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ORIGINAL PAPERS

TERRA COTTA IN ARCHITECTURAL DESIGN[1]

The Part of the Ceramic Chemist

By F. S. Laurence

ABSTRACT

Emphasis is made of the use of terra cotta as an artistic and decorative material. Its successful use demands an architecturally educated talent and a ceramic chemist who appreciates texture, hue and the required colors. The tendency to employ terra cotta to bring out effects of stone masonry design is shown.

Introduction

Produced as an article of purely commercial manufacture terra cotta is nevertheless an essentially artistic material. Perhaps in no other medium used for the construction of our modern buildings is there to be found in equal degree this marriage of utilitarian and aesthetic character.

Brick, for instance, may be used to fulfil purely practical necessities in construction without regard to aesthetic considerations. It may form the backing of a stone or stucco faced wall and be completely hidden from sight. Brick may on the other hand be used for the exterior facing of a wall whose backing is hollow tile, fulfilling in this case an ornamental or decorative purpose. In a similar way other materials may fulfil this varying function.

[1] This paper will be presented at the Annual Meeting of the American Ceramic Society, Columbus, Ohio, Feb., 1925. Recd. Dec. 30, 1924.

Terra Cotta is Decorative

The use of terra cotta however does not carry this divergent possibility. In all cases terra cotta when used must fulfil a decorative function of some character. Even when used in the form of perfectly plain trim for walls of other material it is visible to the sight as a part of the finished surface and therefore enters inevitably into the aesthetic aspect of the building's design. No matter how far removed from the process of art in its production for such purposes its manufacture can never be conceived as entirely apart from and unrelated to the problems of art in the use it must fulfil. Where employed for ornamental enrichment in the various forms of relief modeling which give the final grace to architectural composition its identity as an artistic product becomes even stronger, being so not only from the standpoint of use but in the very method which must be used for its production in that form.

When we enter the field of color effects which are so integrally a part of architectural design its artistic identity receives still further emphasis. From the severest plainness in such commonplace features as sills or ordinary unornamented ashlar to the most ornamental elaboration of decorative form its aspect as color can never be lost sight of, never be disassociated from aesthetic considerations.

Architecturally Educated Talent Essential

It is precisely in this circumstance that the terra cotta industry demands for its successful conduct talent educated in the requirements of architectural design. The governing of manufacture so as to produce an article suited to the purposes of architecture requires this in the business management. The realization of this object in the work performed by various factory departments requires this upon the part of those officials responsible for their direction.[1]

Ceramic Chemist Must Appreciate Textures, Hues and Colors Required

The chemist must be something more than what the term "ceramic chemist" implies in its literal meaning. The most astounding wizardry in the successful production of glazes and colors means nothing if their characteristics of tone, hue and texture are not well related to the problems of use in architecture. Colors and textures may meet every standard of cultivated taste as such and yet be wholly unsuited to the effect which the architect must seek in the final aspect of his building as a work of architecture. Obviously the conduct of experiment in these lines should be guided by knowledge of what can, will or should be used properly in architectural design.

In the terra cotta industry experience has to a large degree removed

[1] The aesthetic taste and knowledge of "styles" required, for instance, in directing the modeling department come immediately to mind in this connection.

uncertainty in appropriate aim and our chemists have responded to the needs of our architects with splendid general efficiency. Yet no true friend of the terra cotta industry will maintain that there is not room for betterment in this regard. The ceramic chemist of most value to the terra cotta industry is the one who combines with his scientific proficiency the most intelligent grasp of the requirements of good architectural design in its use of color and material effects generally.

This does not mean that an actual training in architecture is essential. But study which develops sound discriminative taste in effects of architectural design is a necessity and the question may well be asked, "Are our ceramic schools visualizing correctly the necessary equipment of the ceramic chemist in this regard?" The question of course has relation only to the needs of those ceramic industries whose products are means of realizing aesthetic effects in architecture.

Use of Terra Cotta in Architecture

Tendency in Present Design

In its wide use today, covering almost all classes of building operations throughout the country, terra cotta has been employed chiefly for realizing the effects of stone masonry design. In everything from ashlar to cornices, capitals, brackets, cartouches, medallions and other forms of ornamental elaboration the design in jointing, pattern, profiles and qualities of modeling follows the character of carved stone. Colors and surface textures have likewise repeated this imitative tendency. This is due in great part to the demands of the architectural profession itself whose whole training hitherto has been based on the traditions of masonry design reflected in the architectural monuments of the past.

These architectural monuments of the past came into being, however, when the use of steel for construction was unknown and walls depended for their support upon their mass and weight and the load bearing qualities of material used. The advent of steel as the supporting factor in construction came upon a profession totally unprepared for it in its inherited conceptions of beauty and structural principle. It was scarcely to be expected therefore that a new architectural technique would immediately spring into being more logically adapted to the actual facts of modern construction.

Steel Construction Brings New Treatment

But no such profound change as the introduction of steel in building operations can take place without this altering the entire character of architectural design and ultimately yielding something in style which the world has never before known. The proportional height of our large buildings is one respect in which this mighty change has already manifested itself. One is apt to wonder why the inevitableness of the re-

maining transformation is not more apparent both to those who design our buildings and those who furnish the materials for their erection. Perhaps an analogy may best be drawn in looking back upon the consequences following the invention of the printing press. Little did the people of that time dream that at one blow there was destroyed the very life of the glorious plastic art which hitherto had been the one great channel through which the thought of the times could best express itself.

In somewhat the same way steel, true to its nature, has stabbed to the heart the beautiful forms of architectural design which we have inherited from the ages gone by. Something else will eventually take their place; not suddenly, but in a process of orderly evolution. Whether this is for the better or worse, time only and the judgment of later ages can tell. In its initial manifestations the change has already come and its full accomplishment may prove swifter than we suspect.

The Responsibility of the Ceramic Chemist

The manufacturer of a ceramic material used in architecture must keep his product well abreast of the developing tendencies in the major art which his effort serves. The ceramic chemist responsible for the production of colors in their various shades, hues, and qualities must know in any event what constitutes an appropriate palette for the architect's use. The construction of such a palette should comprehend effects of color appropriate to the different "periods" or styles in architectural design.

Graduated range of shade in any color should exhibit consistent gradation in intermediates from light to dark and preserve in this range harmonious qualities of hue admitting their being used together without clashing. If, for instance, an architect desiring to use blue in several different shades, were obliged to associate a light "warm," yellow tinged blue, with a slightly darker "cold" blue of raw primary cast, and a still darker shade of blue inclining toward purple, because gradation in this color afforded no other choice, the chances would be very little that they could be worked into harmonious combination. And so throughout the palette in the gradations of all other colors and the possibility of their successful relation, using one or more shades of one color with one or more shades of the other.

A trained aesthetic taste must govern the production of glazes and colors from the standpoint of their harmonious use together in design. Finally, this should embody a selection appropriate in any event to architectural purposes and well related to the corresponding characteristics occurring in other materials used in architecture which may be jointly employed.

Does the academic training of our ceramic chemists cover this important field of study in any particular? Under the current tendency to use more color in architecture it is particularly important that it should. The chemist upon whose creative activity the architect must rely for the ma-

terial he uses should understand the language of architecture. New problems in the decorative embellishment of our modern buildings are pressing insistently for a satisfying solution. Color is becoming an important factor in these. The ceramic industry holds within the nature of its material unexploited resources of the most promising nature. The National Terra Cotta Society is bending every effort today in its promotional and publicity work toward bringing an appreciation of these to the architectural profession.

The response has been most encouraging and Government statistics of production in the industry during the past several years show marked increases in the use of terra cotta from year to year since 1921. Beautiful examples of architecture, many of them in color, are appearing in all our great cities and are confined to no one section of the country. Most encouraging has been the tendency to recognize the distinctive charms of ceramic material in many of the forms of treatment given to recent executed work. The National Terra Cotta Society is featuring these in recent publications and others yet to appear in the early future.

The opportunities which the future holds are therefore great for the chemist whose initial training or progressive disposition in his post-graduate relation enables him to fulfil the broader requirements of the modern terra cotta laboratory.

NATIONAL TERRA COTTA SOCIETY
NEW YORK CITY

THE MAKING OF DOLOMITE BRICK AND A STUDY OF THEIR PROPERTIES[1]

By Andrew I. Andrews,[2] George A. Bole[3] and James R. Withrow[4]

ABSTRACT

This investigation deals with the making and the properties of dolomite brick. A thorough review of the literature shows that there are many improvements possible in the making of dolomite brick and some of the principal faults are pointed out.

In this investigation it was shown that 200-mesh dolomite mixtures of a composition 9–0–6M (9% Fe_2O_3–0% Al_2O_3–6% SiO_2–85% dolomite); 6–3–6M (6% Fe_2O_3–3% Al_2O_3–6% SiO_2–85% dolomite); and 2–4–4M (2% Fe_2O_3–4% Al_2O_3–4% SiO_2–90% dolomite) can, if calcined to cone 20 down, be made into better brick than any previously described. The advantages of this higher fired material are (1) it has been more completely shrunk than that fired at lower temperatures and therefore does not shrink as much when refired in the form of brick, (2) in the use of aqueous binders less trouble is encountered due to slaking than with the lower fired material.

In a continuation of the binder studies a thorough investigation was made of molasses, tar, epsom salts, water and carbonated water. No conditions were found where water, carbonated water, bindex or epsom salts, could be satisfactorily used.

Using 20-mesh (2–4–4M) calcine and 15 and 20% of molasses as a binder it was found that the brick always squatted considerably at about cone 15 down. This was shown to be inherent in the material itself and not due to a migration of any part of the material or a softening of the molasses.

The most successful brick were made using 20-mesh D9–0–6M composition (9% Fe_2O_3–0% Al_2O_3–6% SiO_2–85% dolomite 200-mesh calcined to cone 20 down), plus 13% of a one to three dextrin-water mixture as binder, and 20-mesh S6–3–6M (6% Fe_2O_3–3% Al_2O_3–6% SiO_2–85% dolomite 200-mesh calcined to cone 20 down), plus 12% of a 5% solution of sodium silicate and in each case fired to cones 16 to 18 down. These brick are dense, well shaped and refractory.

Cone fusion temperatures of calcines 9–0–6M, 6–3–6M and 2–4–4M were made in an especially constructed oxyacetylene furnace.

The results of the tests show that the above compositions have cone fusion temperatures above cone 40 (2010°C) down. In connection with this work it was also shown that an electric induction furnace, where graphite is used as the resistor, is not reliable for cone fusion tests due to the strong reducing atmosphere.

In a load test on brick D9–0–6M and S6–3–6M it was found that when they are heated to 1350°C and held at 1350°C for one hour under a load of twenty-five pounds per square inch they show only a small compression. Brick D9–0–6M shows a compression of 3% while S6–3–6M shows a compression of 0.9% neither brick showing any tendency to crack or squat.

In a spalling test these brick (D9–0–6M and S6–3–6M) were shown to possess the characteristic fault of magnesite in that they do not withstand sudden heat change

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[1] Published by permission of the Director, U. S. Bureau of Mines.

[2] Fellow, Ohio State University, 1923–24.

[3] Director, Ceramic Expt. Sta., U. S. Bur. of Mines, Columbus, Ohio.

[4] Head of Department of Chemical Engineering, Ohio State University.

Note: This is the third phase of an investigation by the U. S. Bureau of Mines in coöperation with the Ohio State University Engineering Expt. Station into the possibility of utilizing dolomite as a base material in the manufacture of refractories. The data herein given has been presented to the Graduate School at Ohio State University as a thesis in partial requirement for the Doctor's degree.

without spalling. On heating one hour at 1350°C and then exposing to room temperature they crack badly.

The use of less flux was unsuccessful as the material thus prepared shows strong hydration which is fatal in that it causes the material to disintegrate.

Dolomite compositions 9–0–6M, 6–3–6M and 2–4–4M, flux violently with silica and fire brick but are inactive toward magnesia and chrome brick. It is, however, possible to burn the dolomite on fire clay brick if a thick layer of magnesia brick grog is used.

Since it is necessary to grind the dead-burned dolomite before it can be made up into brick it is necessary to know the relative tendency toward slaking of the various size particles. It was found that the finer the calcined dolomite is ground the more rapidly the slaking takes place and that it is in some cases very appreciable for 20-mesh material as used in making brick.

Introduction

Since magnesite suitable for making refractory brick is an expensive raw material and dolomite is relatively cheap, it would be a great saving to the industries using basic refractories if dolomite could be substituted for magnesite.

Robson and Withrow[1] have made a survey of the use of ferric oxide (Fe_2O_3), alumina (Al_2O_3), and silica (SiO_2) as fluxes for dead-burning dolomite and have produced promising compositions.

The object of this work is to investigate the following: (*a*) the use of the compositions suggested by the previous work in the making of dolomite brick, (*b*) the study of the effects of temperature on the properties of the brick to determine the optimum firing temperature including a study of the cause of "slumping" of dolomite brick during firing, (*c*) the thorough study of various binders and their advantages or disadvantages; (*d*) an investigation of the properties of the dolomite brick relative to their applicability to service conditions.

Experimental

Preliminary Work

A very pure grade of dolomite of the Niagara formation obtained from Cedarville, Ohio, was used in this work. It was crushed in a jaw crusher, put through rolls and finally ground in a dry pan to pass 100-mesh. A second batch was pulverized by means of a Jeffrey hammer pulverizer and then ground in a dry pan to pass 200-mesh screen. The chemical analysis of this dolomite, based on the dry weight (110°C), is given in the following table (page 86).

The true specific gravity determined by the kerosene-pycnometer method, of dolomite batch No. 2 is 2.83. Since there is very little differ-

[1] J. T. Robson and J. R. Withrow, "The Dead Burning of Dolomite," *Jour. Amer. Ceram. Soc.*, 7 [1], 61; [2] 141; [3], 207; [4], 300 (1924).

		Batch No. 1	Batch No. 2
Silica	(SiO_2)	0.4	0.38
Aluminum oxide	(Al_2O_3)	.5	.5
Iron oxide	(Fe_2O_3)	.5	.4
Calcium oxide	(CaO)	30.2	30.3
Magnesium oxide	(MgO)	21.8	21.7
Sodium oxide	(Na_2O)	trace	trace
Sulphur trioxide	(SO_3)	none	none
Carbon dioxide		46.8	47.1
		100.2	100.48
Loss on heating to 105°C		.11%	....
Loss on heating to 110°C		....	.24%

ence in the composition of the two dolomites, no distinction will be made in future work.

The following fluxes with their typical analyses are:

Alumina		Ferric oxide		Flint	
Al_2O_3	99.99	Fe_2O_3	99.99	SiO_2	99.80
SiO_2	.001	FeO	none	Al_2O_3	.18
FeO	.003	SO_3	trace	Fe_2O_3	.01
CaO	trace			CaO	none
Cl	trace			MgO	none
SO_3	trace				

Iron ore		Bauxite		Sodium silicate	
Fe_2O_3	88.88	Al_2O_3	50.20	Na_2O	25.13
SiO_2	6.68	Fe_2O_3	3.80	SiO_2	24.95
Al_2O_3	2.01	SiO_2	21.00	H_2O	49.38
FeO	0.00				

The binders in each case will be described in detail when used in connection with the investigation.

Key to Compositions and Definitions

The numbers representing the sample indicate the composition of the flux. The first number represents the percentage ferric oxide, the second number alumina and the third number silica. Letters are used to indicate various modifications. Thus, a composition marked 2–4–4 represents 2% Fe_2O_3, 4% Al_2O_3, 4% SiO_2 and 90% dolomite. 2–4–4M indicates that the composition is the same as above but that 200-mesh material was used in making up the composition for calcining. Other modifications will be given later and explained when first used.

Flux. By the term flux in this paper, it will be understood to mean constituents such as Fe_2O_3, Al_2O_3 and SiO_2 which with part of the dolomite forms the glassy portion of the body.

Binder. By the word binder it will be understood that this is a material used to hold the particles of material together in the green or lightly fired state.

Cones. Orton standard pyrometric cones have been used throughout this work.

Apparent Porosity. Refers to open pore space.

True Porosity. Refers to open plus closed pore space.

Preliminary Investigation

The properties of the brick made according to Robson and Withrow[1] were studied and the feasibility was determined of using commercial material such as iron ore, bauxite and kaolin in place of the pure oxides as fluxes. Cedarville dolomite, 100-mesh, was thoroughly mixed with the fluxes appearing in the following table by means of grinding the batch together.

Brick	2-2-4	2-2-4E	2-2-4C	6-3-6	6-3-6E	9-0-6	9-0-6E
Dolomite	90	90	90	85	85	85	85
Fe_2O_3 C.P.	2	..	..	6	..	9	..
Al_2O_3 C.P.	4	..	..	3	..	0	..
SiO_2 C.P.	4	4	4	6	6	6	6
Iron ore (Fe_2O_3)	..	2	2	..	6	..	9
Bauxite (Al_2O_3)	..	4	..	..	3	..	..
N. C. kaolin	..	..	4	..	..	..	..

When commercial materials were used, corrections were made for the impurities. For illustration: the iron ore contains Fe_2O_3, Al_2O_3 and SiO_2. The amount of ore added will be sufficient to bring the Fe_2O_3 content of the mix up to the required percentage and the amount of Al_2O_3 and SiO_2 to be added will be diminished by the amount contained in the iron ore. Corrections were also made for hygroscopic water.

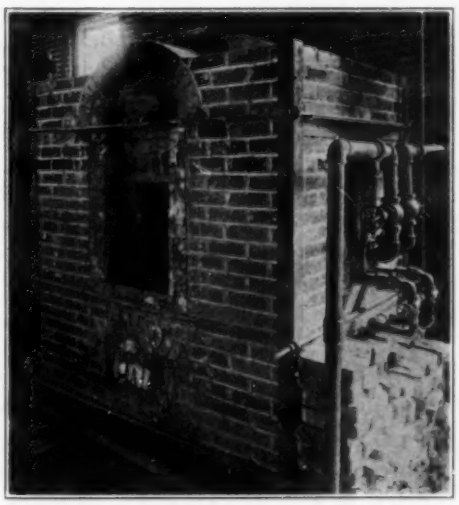


FIG. 1.

After thoroughly mixing the constituents by putting them through the disc pulverizer, sufficient water was added to make them moldable. They were then made into briquettes (1 x 2 x 4") and dried at 110°C. They were set in the down-draft kiln (Fig. 1) on fire brick dusted over with 20-mesh magnesia brick grog. It was necessary to make two firings as all the batch could not be set in the kiln at one time. One-half of each composition, however, was included in each firing.

[1] J. T. Robson and J. R. Withrow, *loc. cit.*

In the second firing the briquettes were set on magnesia brick as they fluxed considerably with the fire brick dusted over with magnesia.

The time-temperature curves are shown on Fig. 2, semi-oxidizing conditions being maintained throughout the firing.

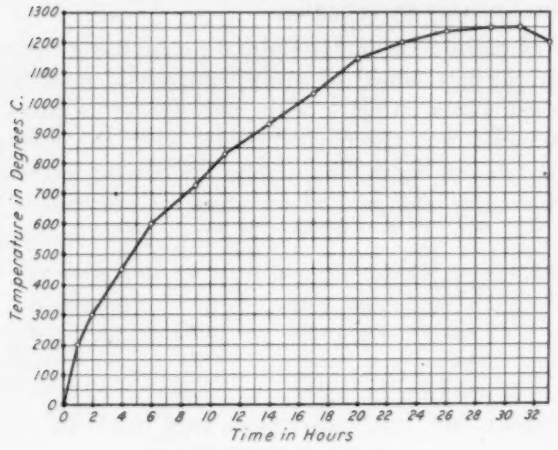


FIG. 2.—Brick firing I–II.

These temperatures were measured by means of a platinum, platinum-rhodium thermocouple extending through the back of the kiln and about four inches through the inside wall into the combustion chamber. In each case, cone 17 was down and cone 18 standing at the end of the burn. The kiln was allowed to cool normally, requiring about two days.

Results of Calcination. The briquettes showed about 40% volume shrinkage, were very hard and black in color shading to a brown on the interior especially in the cases of low iron content.

The briquettes were crushed in a jaw crusher and ground in a disc pulverizer to pass 20-mesh. The screen analysis of this material was as follows:

Calcine mesh	Residue						
	2–4–4	2–4–4E	2–4–4C	6–3–6	6–3–6E	9–0–6	9–0–6E
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	15.0	10.0	10.3	18.0	16.1	21.1	14.6
100	64.8	70.7	67.2	70.3	61.9	62.3	72.4
Fines	20.2	19.3	22.5	11.7	23.0	16.6	13.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

This material was next made up into brick as follows:

Brick M[1]2–4–4. To 3250 grams of the calcined 2–4–4 composition 813 grams (20%) of molasses were added and thoroughly mixed by hand. It was then pressed into a brick at 500 lbs. pressure per square inch and allowed to air dry for two days.

Brick M2–4–4E. To 3244 grams of 2–4–4E dead-burned composition,

[1] The letter preceding the composition number indicates the binder used as M for molasses, S for sodium silicate, D for dextrin.

811 grams (20%) of molasses were added, mixed and a brick molded, pressed and dried as above.

Brick M2–4–4C. To 3407 grams of 2–4–4C (dead-burned), 852 grams (20%) of molasses were added and a brick made as above.

Brick S6–3–6. To 3360 grams of 6–3–6 (dead-burned), 840 grams (20%) of a 5% sodium silicate solution were added, mixed and pressed into a brick by hand. On drying at 110°C this brick cracked badly. It was repressed with 20% more of the sodium silicate solution and dried at room temperature but again it cracked. It was then repressed with 20% more of the sodium silicate solution and subjected to a humid atmosphere for drying but this caused a complete disintegration. It was likely that the cracking was due to the slaking of the lime which caused a swelling of the brick and resulting failure.

Brick S6–3–6E. To 2800 grams of dead-burned 6–3–6E composition, 700 grams (20%) of a 5% sodium silicate solution were added, mixed and pressed into a brick by hand. As with brick 6–3–6, this brick could neither be dried at 110°C nor in room conditions.

Brick D9–0–6. To 3045 grams of dead-burned 9–0–6 composition, 455 grams (13%) of a one to three dextrin-water mixture were added, mixed by hand and pressed into a brick at 500 pounds per square inch pressure. It was dried at 110°C but cracked badly.

Brick D9–0–6E. To 3045 grams of dead-burned 9–0–6E composition, 455 grams (13%) of a one to three dextrin-water mixture were added, mixed, pressed and dried as above but again the brick cracked badly.

Drying Results

1. Brick M2–4–4, M2–4–4E and M2–4–4C dried successfully under room conditions.
2. Brick S6–3–6 and S6–3–6E using 20% of a 5% sodium silicate solution could not be dried under room conditions nor at 110°C without cracking.
3. Brick S6–3–6 could not be dried in a humid atmosphere without disintegrating completely.
4. Brick D9–0–6 and D9–0–6E using 13% of a one to three dextrin-water mixture could not be dried at 110°C without cracking.

Brick Firing No. 1

Since the brick S6–3–6, S6–3–6E, D9–0–6 and D9–0–6E could not be dried successfully, they were not included in this firing. The following bricks M2–4–4, M2–4–4E and M2–4–4C were set on end on magnesia brick dusted over with 20-mesh magnesia brick grog, in a round down-draft kiln. The dolomite brick were protected from the direct flame

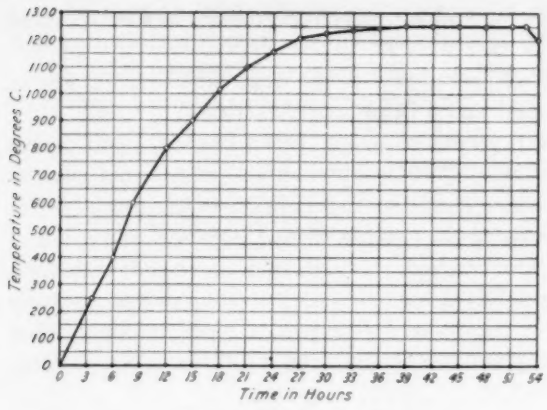


FIG. 3.—Brick firing I.

by a checker of fire brick. The time-temperature curve is shown in Fig. 3, cone 15 being down and cone 16 standing at the end of the forty-five hour firing. The kiln was cooled slowly requiring about two days.

Results of Brick Firing No. 1

All three bricks M2–4–4, M2–4–4E, and M2–4–4C (Fig. 4), had squatted badly, being about one-half inch wider at the base than at the top. There were many small cracks at the base and the brick had sagged over to such an extent as to flux with the fire clay brick standing about one inch away. The characteristic properties of these brick are shown in the above table.

Property	M2–4–4	M2–4–4E	M2–4–4C
Color	black	black	black
Shape	Squatted and warped	Squatted and warped	Squatted and warped
Linear shrinkage	17.1	17.2	17.2
Apparent porosity	10.5	10.7	9.9
Apparent density	2.92	2.87	2.96
Weight	2965 grams	2980 grams	3047 grams

Conclusions. Since these brick have an excessive shrinkage, low porosity and a tendency to squat on firing to cone 15 down, they would not serve satisfactorily as a refractory. The excessive shrinkage has a tendency to crack and warp the ware and presents commercial firing problems, the low porosity shows them to be very vitreous which tends to cause spalling.

FIG. 4.—Brick M2–4–4.

Calcination No. 2

Since none of the brick thus far made stand up to the requirements of a basic refractory it was decided to make several modifications in the process of fabrication. In the first place it was decided to use 200-mesh material for calcining in order to get more intimate

contact between the particles, more complete uniformity and therefore more efficient dead-burning. This would likely do away with some of the slaking action of the ground calcine. Robson and Withrow suggested that the nature of this dead-burning was that of an envelope of flux over the lime particles. Therefore, the smaller the lime particles the more efficient this dead-burning ought to be. In addition to the above modification, it was decided to calcine the material at cone 20 instead of cone 17. This would decrease the shrinkage of the material when it is later made up into brick and fired at a lower temperature.

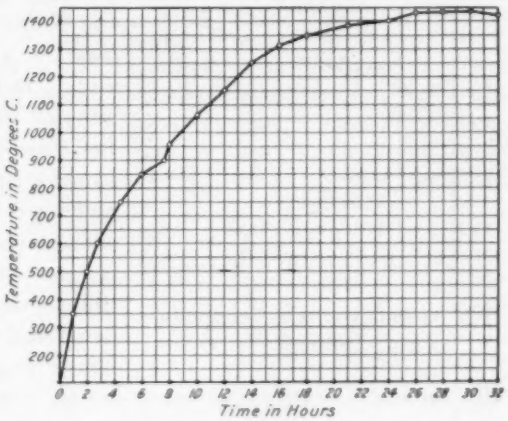


FIG. 5.—Firing II.

Ten kilos each of 2–4–4, 6–3–6, and 9–0–6 compositions were made up with the above modifications. 200-mesh material[1] was used and the calcination was carried to cone 20 down, the time-temperature curve being shown in Fig. 5. This dead-burned material was crushed in a jaw crusher and ground to 20-mesh in a disc pulverizer.

	Per Cent Residue		
Mesh	2–4–4M	6–3–6M	9–0–6M
20	2.0	2.1	3.8
35	39.8	45.0	41.0
48	14.0	9.3	11.1
65	5.8	.2	7.7
100	8.7	8.4	7.2
150	5.2	3.8	3.6
200	5.2	7.0	3.8
Fines	19.2	24.0	21.8
Total	99.9	99.8	100.0

The above table shows the screen analysis of the dead-burned dolomite.

Study of Firing Temperature

Thus far, no systematic study has been made on the effect of firing temperature on the brick. This was therefore the next problem undertaken.

[1] Batches in which 200-mesh material was used and which were fired to cone 20 down, will be designated by following the composition number by the letter M. Illustration: 2–4–4 composition in which 200-mesh material was used and calcined to cone 20 down, will be 2–4–4M.

Briquettes were made up of 2–4–4M, 9–0–6M and 6–3–6M composition using molasses, dextrin and sodium silicate respectively, as binders. For 2–4–4M, 15% of molasses was used as the binder. Ten per cent of molasses has been shown to be insufficient and it is desired to use the minimum amount which will serve the purpose. For 9–0–6M composition, 10% of a one to three dextrin-water mixture was used and for 6–3–6M, 10% of a 5% sodium silicate solution was used. These briquettes were molded by hand and had dimensions of 1 x 2 x 4 inches. They dried well and were very firm and strong. These briquettes were then placed in the kiln on end, on magnesia brick dusted over with magnesia brick grog. Cone plaques were placed beside each test piece and the tests were well protected from the direct action of the flame. Draw trials were taken at regular intervals as shown by the attached table, the test pieces being immediately buried in powdered magnesia to prevent too rapid cooling and spalling. None of these briquettes showed any decided spalling.

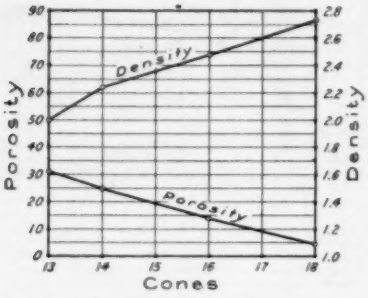


FIG. 6.—Study of firing temperature 9–0–6M.

The apparent porosity and density were determined from data obtained as follows:

1. Weight of briquette dry.
2. Weight of briquette after soaking in kerosene for two days.
3. Weight of briquette suspended in kerosene.
4. Specific gravity of kerosene.

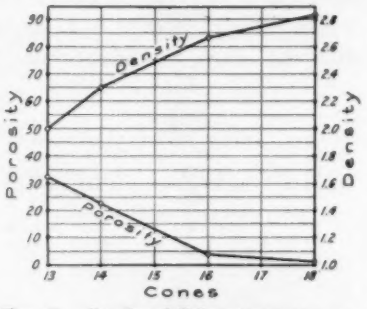


FIG. 7.—Study of firing temperature 6–3–6M.

The specific gravity of the kerosene was determined by the pycnometer method.

The following table (page 93) shows the results of the tests.

These results as shown by the curves in Figs. 6, 7 and 8 give the following information:

1. With increase of temperature there is increased shrinkage.
2. With increase in firing temperature, the apparent porosity becomes less.
3. With increase in firing temperature, the density becomes greater.

Compn.	Cone	Color	Shape	Linear shrink.	Odor	Strength	Apparent porosity	Sp. gr.
2–4–4M	4	green	OK	none	molasses	dusty	crumbled	....
2–4–4M	6	green	OK	none	molasses	dusty	crumbled	....
2–4–4M	8	green	OK	none	molasses	dusty	crumbled	....
2–4–4M	10	grey	OK	none	molasses	dusty	crumbled	....
2–4–4M	12	grey	OK	none	molasses	dusty	58.6	1.37
2–4–4M	14	grey	OK	none	molasses	weak	38.6	1.89
2–4–4M	15	black	OK	10%	molasses	good	38.0	1.99
2–4–4M	16	black	OK	12%	slight	good	35.2	2.07
2–4–4M	17	black	warped	15%	none	good	31.4	2.11
2–4–4M	18	black	bad	17%	none	v. strong	22.3	2.41
2–4–4M	20	black	bad	....	....	v. strong	13.4	2.64
9–0–6M	13	black	good	3%	....	fragile	30.5	2.10
9–0–6M	14	black	good	4%	....	fragile	25.3	2.33
9–0–6M	16	black	good	8%	....	fragile	14.4	2.59
9–0–6M	18	black	good	12%	....	strong	5.0	2.83
6–3–6M	13	black	good	2%	....	fragile	32.8	2.00
6–3–6M	14	black	good	3%	....	fragile	26.0	2.30
6–3–6M	16	black	good	8%	....	fragile	8.3	2.68
6–3–6M	18	black	good	12%	....	strong	1.7	2.83

The apparent porosity, however, is not complete information due to the fact that there may be a great number of closed pores which do not appear in an apparent porosity determination. The true porosity was therefore determined. In order to do this, it was necessary to get the true density of the material. This was done by the pycnometer method using kerosene. In a calibrated pycnometer, the density of the kerosene to be used was accurately determined. About twenty grams of the calcined dolomite was then transferred to the weighing bottle and accurately weighed. The bottle was then filled with the kerosene and a new weighing made. The following information was then known:

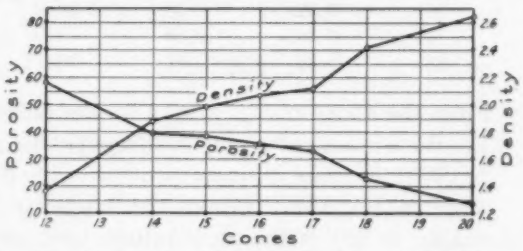


FIG. 8.—Study of firing temperature 2–4–4M.

1. The weight of exactly 50 cc. of kerosene.
2. The weight of the dolomite.
3. The weight of the dolomite plus enough kerosene to make up 50 cc. of volume.

Results show the following densities for the three calcines:

Calcine	Density
2–4–4M	3.31
9–0–6M	3.44
6–3–6M	3.39

It is now possible to calculate the true porosity of the briquettes and also the closed pore space as follows:

D = Density of material
d = Bulk density of briquettes
D : 100% of solid :: d : actual per cent of solid
True porosity — apparent porosity = closed pore space.

The following table[1] shows the results obtained:

Cone	D	d	Apparent porosity	True porosity	Closed pore space
2–4–4M					
12	3.31	1.37	58.6	58.6	0.0
14	3.31	1.88	38.6	42.9	4.3
15	3.31	1.99	38.0	39.9	1.9
16	3.31	2.07	35.2	37.5	2.3
17	3.31	2.11	31.4	36.3	4.9
18	3.31	2.41	22.3	27.2	4.9
20	3.31	2.64	13.4	20.3	6.9
9–0–6M					
13	3.44	2.10	30.5	39.0	8.5
14	3.44	2.33	25.3	32.3	7.0
16	3.44	2.59	14.4	27.6	13.4
18	3.44	2.83	5.0	17.7	12.7
6–3–6M					
13	3.39	2.00	32.8	41.0	8.2
14	3.39	2.30	26.0	32.0	6.0
16	3.39	2.68	8.3	21.0	12.7
18	3.39	2.83	1.7	26.5	24.8

From the above results it may be concluded:

1. With increase in temperature, the true porosity becomes less.
2. With increase in temperature the closed pore space becomes greater.

Since in the above results the briquettes do not reach a maximum shrinkage at any of the temperatures used and since porosity seems to be still changing, it was decided to fire these briquettes to higher temperatures.

For this purpose, a surface combustion furnace was used (Fig. 9) and the temperatures were determined with an optical pyrometer. The test pieces were made up similar to the above briquettes but one-inch cubes were used instead of pieces 1 x 2 x 4 inches as in the above work. This was necessary due to the fact that the heating chamber was very small. These briquettes were placed on a graphite plate, three at a time, 2–4–4M, 9–0–6M and 6–3–6M and heated to temperatures varying from 1575°C to 1800°C. The length of time that the briquettes were held at this temperature varied from thirty to forty minutes and the temperature recorded

[1] The following figures have been calculated on the assumption that the density does not change with firing temperature.

was the average of a number taken during this period. After firing 2–4–4M was most vitreous, 6–3–6M next and 9–0–6M the least. The following table shows the properties of these various briquettes:

Comp.	Cone	Temperature	Density	Porosity
2–4–4M	22	1575	2.94	0.818
2–4–4M	23–24	1604	2.91	1.28
2–4–4M	26	1663	2.60	2.67
6–3–6M	22	1575	3.08	4.26
6–3–6M	23–24	1604	3.00	1.50
6–3–6M	26	1663	2.94	2.53
6–3–6M	27–28	1675	2.79	2.39
9–0–6M	22	1575	3.10	1.98
9–0–6M	23–24	1604	3.34	2.21
9–0–6M	26	1663	3.03	1.92
9–0–6M	27–28	1675	3.00	2.69

The following were heated to 1800°C but the pieces had so squatted and fused together that they could not be identified:

34	1800	2.49	1.77
34	1800	3.05	0.81

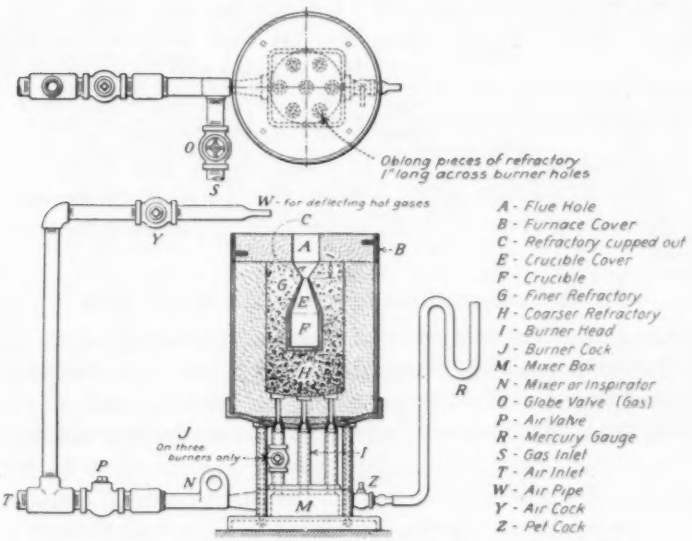

Oblong pieces of refractory 1" long across burner holes
W - for deflecting hot gases
A - Flue Hole
B - Furnace Cover
C - Refractory cupped out
E - Crucible Cover
F - Crucible
G - Finer Refractory
H - Coarser Refractory
I - Burner Head
J - Burner Cock
M - Mixer Box
N - Mixer or Inspirator
O - Globe Valve (Gas)
P - Air Valve
R - Mercury Gauge
S - Gas Inlet
T - Air Inlet
W - Air Pipe
Y - Air Cock
Z - Pet Cock
On three burners only

FIG. 9.—Cone fusion furnace (The Surface Combustion Co.)
Date, April 11, 1922. Scale: 3" = 1 ft.

The above data show that at high temperatures the porosity is low and the specific gravity is greater than at the lower temperatures. The density does not seem to have reached a maximum even at cones 27–28. The shrinkage is progressively greater from the lower to the higher temperatures.

The conclusions of this work on firing temperatures are as follows:

1. It is not desirable to fire dolomite bodies below cone 14.
2. As the firing temperature increases, the porosity decreases.
3. As the firing temperature increases, the density increases.
4. If the briquettes are fired to cones 27–28, they do not reach the true density of the material.
5. The three compositions in order of their vitrification at high temperatures (1575–1675°C) are: 2–4–4M greatest, 6–3–6M next, and 9–0–6M least vitrified.
6. With increase in temperature, shrinkage increases.
7. The closed pore space increases with firing temperature.

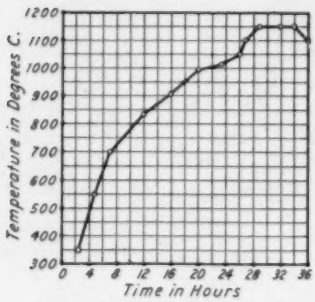


FIG. 10.—Brick firing II. Cone 14 down.

8. The true porosity decreases with firing temperature.
9. 2–4–4M appears to have (below cone 20), greater porosity and lower specific gravity than 6–3–6M and 9–0–6M, while 9–0–6M has less porosity but about the same density as 6–3–6M.
10. 2–4–4M has less closed pore space than 9–0–6M and 9–0–6M has less than 6–3–6M. (Closed pore space is an advantage over open pore space as there is less chance for corrosive action.)
11. The next brick firing was at cones 14, 16, and 18 to determine exactly which is the best firing temperature since results on briquettes are not truly comparable to those which may be obtained with standard sized brick.

Firing Temperatures for Standard Sized Brick

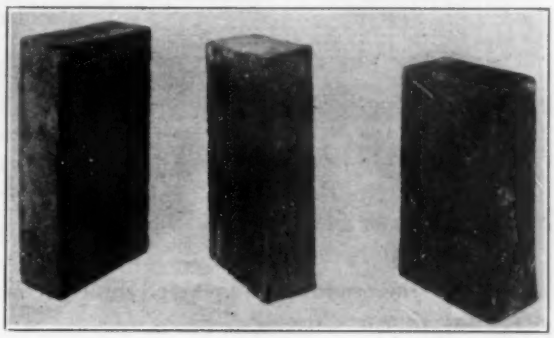
Since the firing temperature as determined by briquettes is not conclusive, it was necessary to make a further study with standard sized brick. Another batch of calcine was therefore made up and as described on page 88, was ground to pass 20-mesh. The screen analysis was as follows:

	Residue, Per cent		
Mesh	2–4–4M	6–3–6M	9–0–6M
20	0.0	0.0	0.0
35	38.5	43.2	42.6
48	16.0	7.9	8.9
65	7.8	5.4	9.1
100	8.7	8.9	7.9
150	5.8	4.2	4.3
200	5.0	7.1	4.0
Fines	18.2	23.3	23.2
	100.0	100.0	100.0

This material was made up into brick as follows:

Brick M2–4–4M To 3000 grams of 2–4–4M (dead-burned), 15% of molasses was added and thoroughly mixed by hand. It was then pressed into a standard sized brick at 500 pounds pressure per square inch and dried in the air for two days.

Brick S6–3–6M To 3000 grams of 6–3–6M (dead-burned), 13% of a 5% solution to sodium silicate was added and thoroughly mixed. It was then pressed into a brick by hand and dried for twenty-four hours at 110°C. It dried very well, showing no cracks although weak before drying.



D9–0–6M S6–3–6M M2–4–4M

FIG. 11.

Brick D9–0–6M

To 3000 grams of 9–0–6M (dead-burned), 13% of a one to three dextrin-water mixture was added and after mixing the batch, was pressed into standard sized brick at 500 pounds pressure per square inch. This brick dried very well at 110°C in twenty-four hours.

Brick D9–0–6 To 3000 grams of D9–0–6 (dead-burned), which had cracked badly with dextrin as a binder, 750 grams of molasses was mixed. This mixture was pressed into a brick at 500 pounds pressure per square inch. It dried well at ordinary temperatures.

These brick, S6–3–6M, D9–0–6M and M2–4–4M were then set on end on magnesite brick dusted over with magnesite brick grog. A checker of fire brick was built around each dolomite brick to protect it from the direct action of the flame. The round down-draft kiln was used. The time-temperature curve is shown on Fig. 10. The brick were fired to cone 14 down in thirty-four hours. Cone plaques placed in various locations in the kiln showed that the heating was very uniform

Results of Brick Firing No. 2

Brick D9–0–6M and S6–3–6M were very firm and strong with sharp edges and little tendency to warp or squat. Brick M2–4–4M, however, squatted slightly, being a little larger at the base than at the top but was otherwise very good. The properties of the brick were carefully determined as follows:

The volume was calculated by means of five linear measurements in each direction, averaged, and the results multiplied by each other.

Length x width x thickness = volume.

The density was determined by dividing the weight by the volume:

$$\text{Density} = \frac{\text{volume cc.}}{\text{weight gms.}}$$

. The linear shrinkage was determined by measuring the distance between points represented by the intersection of two lines. The original distance between these points, minus the final distance, divided by the original distance and multiplied by one hundred equals the percentage linear shrinkage.

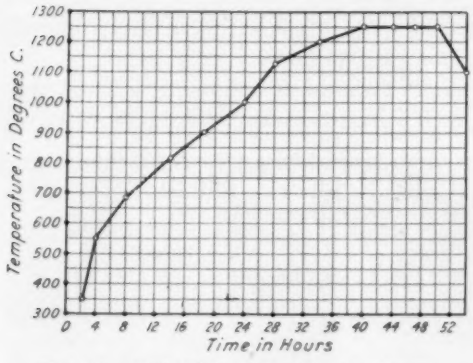


FIG. 12.—Brick firing III. Cone 16 down.

The apparent porosity of these brick was determined by means of an air expansion brick porosimeter.[1]

Brick Firing No. 3

After these tests were completed, the brick M2–4–4M, D9–0–6M and S6–3–6M were reset in the kiln as for brick firing No. 2. They were fired to cone 16 down in fifty hours according to the time-temperature curve, Fig. 12. The kiln was again allowed to cool slowly and the brick were again tested as after brick firing No. 2. M2–4–4M had squatted slightly more after firing to cone 16 than cone 14 down. The appearance of D9–0–6M and S6–3–6M was not appreciably changed.

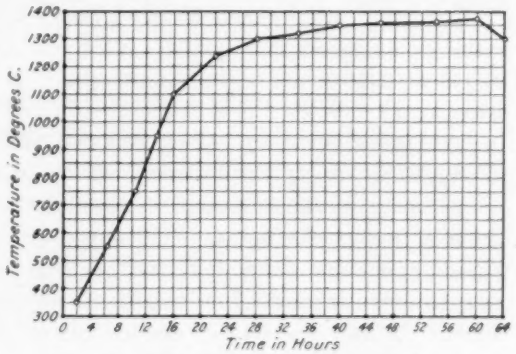


FIG. 13.—Brick firing IV. Cone 18 down.

Brick Firing No. 4

When the tests on brick M2–4–4M, D9–0–6M and S6–3–6M were completed, they were again set in the kiln as for brick firing No. 2. This

[1] E. E. Pressler, *Jour. Amer. Ceram. Soc.*, **7** [3], 154 (1924).

firing was carried to cone 18 down in sixty hours, the time-temperature curve being shown on Fig. 13. The kiln was slowly cooled for three days and the brick removed and tested as in the two previous firings. Brick M2–4–4M showed decided squatting but D9–0–6M and S6–3–6M were fairly good, showing, however, a slight tendency to squat.

The results from the tests on bricks M2–4–4M, D9–0–6M and S6–3–6M when fired to cones 14, 16 and 18, are shown in the following table:

	M2–4–4M Molasses			S6–3–6M Sodium silicate		
Cone	14	16	18	14	16	18
Color	black	black	black	black	black	black
Linear shrinkage	6	15	19	3	9	12
Weight	2939	2908	2819	2948	2942	2791
Volume	1386	1077	973.7	1245	1107	1112
Bulk density	2.12	2.70	2.89	2.33	2.66	2.51
Porosity	35.84	15.23	10.86	30.61	20.33	25.07

	D9–0–6M Dextrin		
Cone	14	16	18
Color	black	black	black
Linear shrinkage	0	4	7
Weight	2905	2898	2887
Volume	1304	1166	1020
Bulk density	2.26	2.48	2.83
Porosity	35.48	27.79	15.15

All three of these brick are very good, the only great fault is that brick M2–4–4M shows some squatting. Each brick is very hard, firm and strong.

When fired to cone 14 down, the porosity 30.61 to 35.84% is too great for a refractory brick. It gives too much surface to the penetration and action of slag. At cone 16 the porosity 15.23 to 27.79 is better but at cone 18, a porosity of 10.86 to 25.07 is more desirable. The shrinkage of M2–4–4M is very great at any temperature above cone 14 while for brick D9–0–6M and S6–3–6M, the shrinkage even at cone 18, while high, is not excessive.

Brick M2–4–4M shows a sudden loss in weight of 89 grams (about 3%), between cones 16 and 18. This loss is likely due to volatilization of some of the more volatile constituents.

Brick S6–3–6M also shows a sudden loss in weight of 151 grams (5.1%), a slightly lower density and a decided increase in porosity. This again appears to be a case of volatilization, since if a particular constituent distils out of the mass, it would likely leave it porous, lower its bulk density and also cause a loss in weight.

Brick D9–0–6M does not show any similar decided variation.

Conclusion on Brick Firing

1. Brick D9–0–6M has the least shrinkage and when fired to cone 18 down, has a porosity of 15.15% which is neither excessive nor so low as to make the brick sensitive to heat change. It is concluded as being the best brick thus far produced.

2. Brick S6–3–6M has a permissible shrinkage of 9% at cone 16 down and if this temperature treatment is used it has a satisfactory porosity of 20.33%. It is a very good brick and can be considered to be almost as good as brick D9–0–6M.

3. Brick M2–4–4M is much less satisfactory than D9–0–6M and S6–3–6M due to the squatting, high shrinkage and low porosity.

The most desirable temperature for firing brick M2–4–4M is cone 14 down; for brick S6–3–6M, cone 16 down and D9–0–6M, cone 18 down. Due to shrinkage and squatting these brick will not meet the requirements of industrial use above the temperature at which they are fired.

(To be continued)

BETTER TERRA COTTA SLABS[1]

By F. B. Allen[2]

ABSTRACT

Terra cotta slab problems are discussed as to (1) refractoriness, (2) mechanical strength, (3) accurate dimensions, (4) temperature changes, (5) spalling, (6) thermal conductivity, and (7) abrasion. Mixes of two experimental bodies are given. The second consisting of 30 grog, 15 clay of low plasticity and 55 bond clays gave satisfactory results.

Introduction

The improvement of his product is the desire and aim of every honest manufacturer. He is constantly on the lookout for means, either of a mechanical or constitutional nature, whereby he may be enabled to attain this end. But before making any fundamental changes he must be reasonably certain that they will produce the desired result and that they are of sufficient importance to warrant such changes. As we all know, basic changes are generally expensive.

The Terra Cotta Slab Problems

Our understanding of this problem is as follows:

High Refractoriness This is not essential. The body must be sufficiently refractory to carry the load without warpage or deformation. As most terra cotta manufacturers are firing to cone 8 or less, this particular feature comes within easy range.

Mechanical Strength This is very important, not because of the load under fire (this is not severe) but chiefly because of the handling of the slabs in setting and drawing the kiln. A 3 x 24 x 24-foot slab made by the soft-mud process, weighs approximately one hundred and twenty pounds. Unless the kiln setters and drawers are conscientious and careful, much breakage is produced in these operations. It is obvious that a strong and tough slab will stand rough handling much better than one which is weakly bonded.

Accurate Dimensions These are desirable. Extreme accuracy is not worth attainment, but slabs measuring within reasonable limits are easy to produce. Such slabs are placed rapidly, produce an even bearing, and are therefore more economical.

Temperature Change While the rate of temperature change under normal conditions is low, a slab, able to stand sudden thermal changes, will often be advantageous.

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[1] Recd. Dec. 27, 1924. Presented at the Atlantic City meeting, Feb., 1924. (Terra Cotta Division.)

[2] Ceramic Engineer, M. D. Valentine & Bro. Co., Woodbridge, N. J.

Spalling Slabs should be non-spalling and free from "spit-out" for evident reasons.

Thermal Conductivity A slab should have a relatively high thermal conductivity to aid in the even distribution of heat and uniformity of firing.

Abrasion While a slab is not subjected to any abrasive action under fire, nevertheless in handling into and out of the kiln considerable rubbing takes place. A slab should be sufficiently tough to resist this action.

Effect of Materials

These various characteristics are attained through the proper selection of materials and methods of manufacture.

Refractoriness is controlled through the clay bond and also the grog. In this particular problem a considerable range of clays is available. One limiting factor is that of the original firing. It is safe to assume that if the slabs come from the kiln having received a normal cone 12–13 firing, true and accurate, they will stand in this respect the lower terra cotta firing.

Mechanical strength and toughness is a question of bonding clays and size of grog. There appears to be a lack of agreement among the different experimenters and users as to the effect of size of the grog. Some have obtained results which indicate that a stronger slab is produced by using grog of varied sizes. Others have found that in their particular problem, large coarse grog gives better load carrying qualities and longer kiln life. Professor Brown[1] says in reference to a sagger mixture, "In a sagger mixture in which there is a preponderance of large sized grog particles, the spaces between the grains are filled with the bond clay which, in vitrifying, allows the particles of grog to slide upon each other. Instead of having a skeleton of grog particles touching at many points and held together by the bond clay we have a matrix of bond clay in which are embedded the grog particles and the bond clay becomes the predominating factor in the behavior of the mixture. If there is a preponderance of large sized grog particles there will be an excess of bond clay between the grog grains, and the bond clay having a greater shrinkage than the grog, decreases in volume and pulls away from the grog particles causing a strain and producing the small cracks which are bound to decrease the mechanical strength of the sagger."

This statement coincides with our views. But then, in a recent article

[1] Geo. H. Brown, "Notes on Sagger Clays and Mixtures," *Jour. Amer. Ceram. Soc.*, **1** [10], 716(1918).

W. S. Williams[1] found that "under comparable conditions as met in large scale factory practice, the practical elimination of grog particles finer than 40-mesh has resulted in increased service from refractory clay, glass-drawing pots."

It is rather difficult to understand the high mechanical strength of a coarse grog body. One must conclude that the bond clay in this case must be selected with great care.

Spalling appears to be a function of the thermal expansion and contraction of the body. Open firing clays have less tendency to spall because of their greater surface of radiation. Howe and Ferguson[2] found that the reduction of a plastic dense firing clay to 20% of the batch and a corresponding increase in the open firing clay entirely eliminated spalling.

As to thermal conductivity, in general, the denser the slab, the higher will be the rate of conduction. Inasmuch as it is desirable for other reasons to have a hard and comparatively dense slab, a mixture of good thermal conductivity will also give the other requisite properties.

Experimental Bodies

The clays used in the following mixtures are all produced in the Woodbridge district. Broadly, they are all refractory clays, differing chiefly in the degree of plasticity. The mixtures are produced on the volume basis, tempered by the ring pit method and molded by hand. The water content is just sufficient to render the mud to the "soft" condition.

For quite a period of time the following mixture was used for these slabs.

26 grog
50 clay of low plasticity
24 bond clays
100

In general, terra cotta slabs of this mixture gave only fair results. They were accurate and true, but were too refractory for the service required.

The first change made in the above consisted in raising the grog to 35%. Also the grog was selected so that there was more variation in size than in the former mixture. The proportion of the grog was increased with a corresponding decrease in the proportion of the clays of low plasticity. The bond clays remained as before.

[1] W. S. Williams, "Effect of Various Sizes of Grog Particles on Clay Pots," *Jour. Amer. Ceram. Soc.*, **6** [11], 1148 (1923).

[2] R. M. Howe and R. F. Ferguson, "A Study of Spalling," *Jour. Amer. Ceram. Soc.*, **4** [1], 32 (1921).

The slabs were a decided improvement. They were harder—had a clearer ring and gave much better service than the original mixture, but they were found to be a little too refractory with the result that the following mixture was tried:

30 grog
15 clay of low plasticity
55 bond clays
100

The grog in this mixture was selected for size as above. The mixture was prepared in the same manner as were also the slabs.

The results obtained have been very satisfactory. They seem to have the requisite characteristics enumerated at the beginning of this article.

In conclusion, the writer wishes to thank R. L. Clare of the Federal Terra Cotta Company for his interest in checking up the performance of these mixtures under their service conditions. Without this assistance very little progress could have been made.

M. D. Valentine & Bro. Co.
Woodbridge, N. J.

Discussion

Mr. Plusch: Our problem in slabs for grinding wheels is a very much more difficult problem than for terra cotta. The wheels weigh much more than terra cotta. They are solid and the abrasive has a specific gravity of nearly four. Our losses in slabs are much greater. We lose ware on account of defective slabs and these losses are considerably greater than in terra cotta because the value of our raw material alone runs around twelve cents per pound. So you can see that slabs which fail with us are a very serious proposition.

I have jotted down a few notes to stimulate thought regarding the manufacture of better slabs. Do we start right in the manufacture of slabs? Do we not pile our clays around in promiscuous places, wherever there is a convenient spot? Do we see that they are clearly marked? Do we test each car and follow it up as closely as we do the raw materials which enter into our product? I believe very few of us give anywhere near as much attention to the raw materials that enter into our slabs as we do the inspection and technical control of the product which we are manufacturing, whereas the very foundation of the material which we are making consists of the slabs on which the material rests while it is being fixed by heat. Do our mixture cards go out to the slab department in good, clear, concise form? Or, does some fellow measure with a wheelbarrow and make marks on the wall or some convenient board showing in a very crude manner what has been weighed?

Undoubtedly most of us know what size grog should be used, know that we should eliminate the fines and know that certain clays will not

make good refractory slabs. After we have once determined what clays to use and what amount of each kind of clay to use, what size and amount of grog, how few of us consistently follow up succeeding batches to see that they are correctly proportioned, soaked and pugged? Slab mixtures are pretty generally slighted in most plants, and this is the main point that I wish to bring out.

Granted that we do inspect our clays carefully, proportion them carefully and accurately, that we use the proper grog, that we pug our clay correctly, do we fall down in the next step, namely, put the poorest laborer we can find around the place to making slabs? This is often the procedure in many plants and it seems to me to be the one place of all places where a good man should be put and kept, not changed around, and that the manufacture of slabs should not be left to any "green-horn" that is hired.

I do not think the clays we use play as important a part as the manner in which we use them. Just select good refractory clays, plastic and non-plastic, free from sand, good clean grog, free from fines, and you have the basis of as good a clay slab as can be made. The most important thing in the mixture, of course, is the skeleton or grog which is used, but here again comes the chance of slighting the mixture, once a proper mix has been determined. Maybe we have not time to size the grog properly, and we just rush ahead. Soon rush methods become standard, they are changed by the fellow who keeps the record in his hip pocket, instead of being directed to the laboratory, and losses keep creeping in.

Again I want to make a plea for more definite control of slab mixtures, from clay to the grog, through the preparation, through the pressing, through the drying, setting and firing. Take the firing for instance: it has been my experience in many places that slab kilns can be lighted and fired most any way, as long as they are fired slightly higher than the ware, under which they are to be used. No particular records are kept on the firing of the slab kilns, no predetermined charts laid out, no definite height determined as the best height for setting to prevent warpage or straining in firing. And here we ruin what might otherwise have been a good product. A good, common sense follow up of standard methods, but followed up continuously and religiously, will result in less slab losses and better slabs.

Firing records on experimental mixtures should not be left to someone who draws or sets kilns, but should be followed specifically by someone who has a knowledge of what he is doing. Too often good mixtures are started through and lost by some one fellow who has forgotten to keep track of them.

There are, of course, many problems which have not been settled regarding the best mixture, the best amount of grog, etc., but of course these conditions will vary for each plant and each different industry, and are

problems on which coöperative research is often a value, but in which independent plant research is of the most value.

It is a question whether or not clay is the proper material from which to make slabs. A great deal of work has been done lately using silicon carbide in slabs. These should give an excellent account of themselves on account of their greater heat conductivity and their low coefficients of expansion. Of course, their price is initially very high and they would have to give many firings to be economical. Thinner bats may also be permissible in this material, thus effecting still greater economies. Mica schists have been suggested as refractories and some little work has been done on them in slab mixtures but has not been advanced far enough to get definite data.

There are many problems of a technical research nature that suggest themselves to me, but I am avoiding them at this time in making a plea for close follow-up on methods to see that they are carried out as outlined and consistently duplicated. This, to my mind, will be one of the biggest factors in producing better terra cotta kiln slabs.

I take this opportunity to ask any of the members of this Division to call at any time to see our plant at Philadelphia and to see our method of making and using slabs, which in our particular industry, are generally termed bats.

MR. BEECHER: It is worth while to emphasize the point which Mr. Plusch has just made, that control of mixtures and processes in the manufacture of slabs is usually slighted. The principal attention is given to the product of the factory and the manufacture of this essential piece of equipment is given but little thought until losses become very serious. Then when improvements are made or defects corrected the slabs are again forgotten until a similar story is repeated.

The use of very fine grog should be avoided. It produces a structure that cracks more readily upon heating and cooling in spite of the fact that it is much stronger mechanically. To keep the content of fines reasonably constant, it is necessary to keep close watch of the materials. When broken slabs are ground for grog in a dry pan for example, wet slabs will produce more fines than dry. Also when repairs are made to the machine, such as the replacement of plates or scrapers, there may be very marked differences in the fineness of the resulting grog. It is advisable, whenever possible, to screen the grog and use only a specific size or mixture of sizes. In this way variations due to the conditions of the machine and of the ma terial ground can be avoided.

Slabs made by machine pressing are commonly inferior to those hand made. This is probably due to the cracks formed in the crumb during pressing. These cracks collect oil from the surfaces of the mold and when the sides are forced together again at the end of the stroke the oil prevents

the healing of the crack. This mechanism can be readily observed if the plunger is withdrawn at different stages of deformation of the crumb and the development and subsequent closing of the cracks observed.

Unfortunately it is not possible as yet to state definitely what economies would result from the use of silicon carbide slabs in the terra cotta field. They have been used for some time in the manufacture of grinding wheels and records of 40 to 50 firings per slab have been reached but the slabs are still in use so the total life to be expected is not known. Under similar conditions normally good fire clay slabs give five to six firings.

E. C. HILL: Our slab loss is about 3 or 4% which means that our slabs will stand twenty-five or thirty firings. In firing with coal, the temperature change is not so great as with oil, and as a result, our slabs stand up better.

ON THE STRENGTH OF HEAVY CLAY PRODUCTS

By J. H. Griffith[1]

ABSTRACT

The published strengths of standard clay products have been formulated in simple equations (1) for placing the information in a simple compass for architects and ceramists, (2) to show the law of variation in terms of properly chosen variables, (3) to aid in appropriate selection of variables in devising future tests. The author assumed that a plus or minus variation or "tolerance" of 10% from the averages found by tests would be acceptable to manufacturers and ceramic engineers and has endeavored to keep well within these limits.

Introduction

It is the purpose in this paper to discuss simple laws for defining the strengths of heavy clay products. It is assumed to this end that the practical needs of ceramists and engineers will be subserved if these strengths are determined so that the probable errors shall not exceed five or ten percentages of the averages found by tests. It will be shown that this can be done with a little statistical correlation and proper choice of variables.

Building Brick

The researches of Howard, Bragg, and others suggest the compression strength of a brick is a function of the type of clay, the method of manufacture, its density and degree of firing in kiln, the modulus of rupture of the brick, etc. The writer is of the opinion that the most opportune choice of a single independent variable would be the "absorption." The degree of firing and density have already been correlated by Orton[2] with the absorption percentage. Recent information conveyed to the author by Paul Cox, Head of the Ceramics School of Iowa State College, leads him to expect that absorption connotes to some extent geographical location. The absorption test is very simple requiring a minimum of apparatus, little technical skill, with attention only to getting initial and final weights.

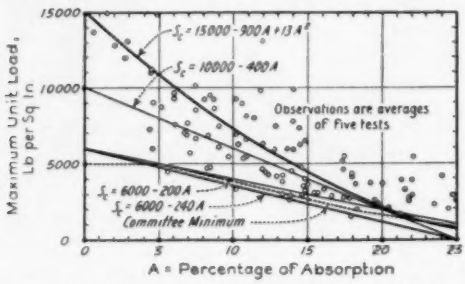

Fig. 1.—Compression strength of American brick.

A plot of the data collected by the Committee C-3 of the American Society for Testing Materials on American building brick shows that the compression strength for all practical purposes is a decreasing function of the absorption. A fairly representative portion of this data has been com-

[1] Prof. of Experimental Engineering, Iowa State College, Ames, Iowa.

[2] *Proc. A. S. T. M.*, **15**, 263.

piled in a convenient compass by Professor Withey.[1] This is plotted in Fig. 1, each observation being a mean of five tests. The simple law, $S_c = 15{,}000 - 900A + 13A^2$ gives the average compression strength of an American brick in terms of the absorption, A, and in practical conformity with the statistical treatment of the theory of Least Squares In other words the sums of the squares of the deviations (residuals) or the moments of the approximate errors are taken small. The figures have been selected to give satisfactory constants for practical computation.

An equation $S_c = 10{,}000 - 400A$, still simpler for mental calculation, may be found by taking the approximate trace of the lower range of probable error deviation. In other words it is much better than an even wager that the compression strength of an American brick will exceed the value given by this equation. Brick with absorptions greater than 25% are automatically eliminated. There are few such.

The equations $S_c = 6000 - 240A$ or $S_c = 6000 - 200A$ are still more conservative and fully as simple for mental calculation. They meet moreover the spirit of the rulings of the Committee if not the exact letter. The strengths automatically vanish for absorptions exceeding 25 and 30%, respectively.

Brick Piers

The tests of large brick piers conducted by Bragg[2] under the advisory direction of Orton and Bleininger are still being discussed by the members of this SOCIETY. One may, however, disregard, in the writer's experience such subtilities as "grades," "bonds," "courses," and even the ages of the mortars of the test specimens, in favor of the fundamental variable—as before, the absorption. The author has found after a number of trials and modifications that the following equation meets the analytic function of strength very satisfactorily within the domains imposed:

$Sp = mg[3800 - 300A + 6\frac{1}{2}A^2]$

Sp = compression strength, pounds per square inch

A = percentage of absorption

m = 1 for cement and cement-lime mortars (1:3)

= $\frac{1}{2}$ for lime mortars (1:6)

= $\frac{1}{4}$ for lime mortars (1:3)

g = 2.8 for New Orleans District

= 2.2 for New York District

= 1.2 for Chicago District

= 1.0 for Pittsburgh District.

The subsidiary variables mentioned previously have no pronounced bearing on the strength as far as statistics show. The salient strength func-

[1] Johnson's "Materials of Constructions," 5th Ed., pp. 282–3.

[2] Bur. Stand., *Tech. Paper* **111** (1918).

tions have been calculated and recorded in Table I for comparison with the averages of the tests. The reader may calculate the average deviation close enough mentally from the table and easily form his own inductions as to the probable error when employing the equation.

Hollow Tile Walls

The rule employed in cement proportioning suggests itself in dealing with hollow tile walls. In other words one might say the strength is a direct function of an independent variable connoting,—say modulus of rupture, degree of firing in kiln, tensile strength, etc., and is an inverse function of voids, absorption percentage, or unity minus density. Contrariwise since Orton has correlated the relative vitrification with absorption and Hathcock has shown the strength of tile individuals is a decreasing function of this variable, the absorption would appear again to be the essential conditioning variable. In view of the fact that "run of kiln" is apt to be chosen in building construction resulting in a chaotic distribution as regards absorption factors, it would seem wise to select another variable. A study of Whittemore and Hathcock's recent paper[1] indicates that the gross area per lineal foot of wall measured transversely is a variable that will best appeal to both architects and builders in a simple equation of the form $S_t = K[cA_g + N]$. As an illustration, taking the Ohio tile of this investigation having the "cells" vertical the strength per running foot of length of wall is $S_t = 15[8A_g + 1]$ with the strengths of tile for the cell axes running horizontal about 0.4 as much or $S_t = 6$-$[8A_g + 1]$. The data for the New Jersey lot of tile are too meager for precise inductions. The walls in this research were constructed to realize the maximum efficiency of the product rather than commercial practice. The strengths estimated by equations should be modified by architects to conform with practice.

Drain Tile

While the strength of drain tile is conditioned by the absorption and other minor variables it is clear the rated diameter is the major independent variable. The equation $S_D = K\left[1050 + 10D + \frac{2D^2}{3}\right]$ appears to meet all the analytic needs of a practical formula conforming to the ruling of the Committee of the A. S. T. M.[2] quite closely considering the simple computing parameters involved. Table II shows the concordance of the equation with the published strengths using parameters $K = 0.7$ for farm tile, $K = 1.0$ for standard drain tile, and $K = 1.4$ for extra quality drain tile.

[1] Bur. Stand., *Tech. Paper* **238,** 525 (1923).

[2] Stand. Specif. A. S. T. M. for 1916.

TABLE I

STRENGTH OF LARGE BRICK PIERS BY TESTS AND BY FORMULA. $Sp = mg[3800 - 300A + 6\frac{1}{2}A^2]$

Sp = compression strength, lbs./in.² A = absorption percentage m = mortar g = location factor

District	Pittsburgh						Chicago		New York		New Orleans	
	$g = 1.0$						$g = 1.2$		$g = 2.2$		$g = 2.8$	
Absorption A	Cement or Cement-Lime Mortar $m = 1$		Lime Mortar 1:½ $m = \frac{1}{2}$		Lime Mortar 1:3 $m = \frac{1}{4}$		Cement-Lime Mortar 1:3 $m = 1$		Cement-Lime Mortar 1:3 $m = 1$		Cement-Lime Mortar 1:3 $m = 1$	
	Formula	Test	Formula	Test	Formula	Test	Formula	Test	Formula	Test	Formula	Test
Percentage	lbs./in.²											
1.28	3427	3800, 3220, 3300 Av. 3440										
4.08	2684	2710, 2740, 2900 Av. 2783	1342	1450, 1270, 1360 Av. 1360								
7.46	1924	2000, 2070, 1760, 1760 Av. 1898	962	840, 890, 990 Av. 907								
15.16	746	870, 870, Av. 870										
16.20	646						775	840, 790, 810, 750, 700, 710 Av. 767				
16.28	639	510, 560, 650 Av. 573			160	210, 178, 126 Av. 171						
16.40	628								1382	1170, 1300, 1260 Av. 1243	1758	1630, 1790 Av. 1710
16.80	595										1666	1450, 1760 Av. 1605
17.10	571										1599	1880, 1690, 1660 Av. 1743
18.60	470								1032	1280, 1280, 1220 Av. 1260		
19.30	431								948	1070, 1060, 1020 Av. 1050		

TABLE II.—STRENGTHS FOR DRAIN TILE OF COMMITTEE A. S. T. M. AND BY FORMULA

$$S_e = K\left[1050 + 10D + \frac{2D^2}{3}\right]$$

S_e = Average supporting strength in pounds per lineal foot
D = Internal diameter of tile. K = parameter as follows

Internal diameter, inches	Minimum supporting strengths per foot					
	Farm drain tile $K=0.7$		Stand. drain tile $K=1.0$		Extra quality drain tile $K=1.4$	
	Formula	Comm.	Formula	Comm.	Formula	Comm.
4	771	800	1102	1200	1543	1600
6	794	800	1134	1200	1588	1600
8	821	800	1173	1200	1642	1600
10	852	800	1217	1200	1704	1600
12	886	800	1266	1200	1772	1600
14	925	900	1321	1200	1849	1600
16	967	1000	1381	1300	1933	1600
18		——	1446	1400	2024	1800
20		Limit	1517	1500	2124	2000
22			1593	1600	2230	2200
24			1674	1700	2344	2400
26			1761	1800	2465	2600
28			1853	1900	2594	2800
30			1950	2000	2730	3000
32			2053	2100	2874	3200
34			2163	2200	3028	3400
36			2276	2300	3186	3600
38			2393	2400	3350	3800
40			2517	2500	3524	4000
42			2643	2600	3700	4200

Sewer Pipe

The same formula employed for drain tile applies to sewer pipes tested according to standards of A. S. T. M. on two point bearings and of diameters ranging from 4 to 42 inches if the parameter K has a sliding scale ranging 0.9 to 1.3 in the interval 4 to 42 ($0.9<K<1.2:4<D<42$).

Conclusions

The conclusion is drawn that a rational theory for the strengths of the heavy clay products is easily possible of attainment. It will be partly dynamical and partly statistical. Such a theory should not be concerned with utilitarian motives alone as in the present case. Instead the laws of the various stress functions should be expressed as mathematical surfaces in terms of all the conditioning variables for analytical study and the scientific development of the subject. A theory of heavy clay products, including pavers, at the present time would greatly aid in formulation of a logical rationale for future testing practice and would reduce the uncertainties involved by extrapolation at the present time.

NOTE: The writer acknowledges the criticism and advice of Paul Cox and D. A. Moulton in the preparation of this paper.

NOTES ON TERRA COTTA BODY SHRINKAGE[1]

By P. G. Larkin and E. R. Curry

ABSTRACT

Notes on method of preparing a terra cotta body, proportioning by volume and using unground material, and method of preparing body, proportioning with ground materials, using disc feeders, are given. Notes on checking laboratory work with these two methods and variation in shrinkage due to amount of water in the body are also considered.

The problem of shrinkage control of the terra cotta body is a somewhat prosaic but very necessary task. These few notes are presented because of the points of general interest they may contain on this problem.

Until recently we have used the older method of proportioning a terra cotta body, using certain volumes of clay, coarse crushed grog, or other material. In the system now in use all materials are ground separately to pass a fine screen, and then proportioned with disc feeders.

These notes are the result of observations during the change from one process of body preparation to the other.

In the older method of preparation, there was little attempt to crush the lumps of clay. Any size which could pass through the bin outlet was used.

The grog had only undergone a preliminary crushing such as is accomplished by gyratory crushers.

The non-plastic clay referred to hereafter was fairly finely divided by the time it was placed in the bins.

The materials were fed from the bins into what was called a mixing car of about forty-five cubic feet capacity. There was an endeavor to get a certain height of each material in the car; the contents of the car were then dumped into a hopper and fed into a dry pan. The body was ground to pass 14-mesh.

A typical body composition by volume, using this method, follows:

$$\text{Per cent} \begin{cases} 41.0 \text{ terra cotta clay} \\ 11.7 \text{ non-plastic clay} \end{cases} \quad 47.3 \text{ grog}$$

In the new method of body preparation all the materials are ground separately in a dry pan to pass 14-mesh screen. They are then proportioned by means of disc feeders. The volume composition of a body having practically the same shrinkage as the one above was

$$\text{Per cent} \begin{cases} 50.3 \text{ terra cotta clay} \\ 9.0 \text{ non-plastic clay} \end{cases} \quad 40.7 \text{ grog}$$

The change in proportions of volumes of clay and grog in the two methods of preparation is due to a greater volume increase of the clay, which is in a much finer divided state than the grog. On the basis of weights of course both compositions must be the same.

[1] Presented at the Summer Meeting, Los Angeles, Calif., Oct. 6, 1924.

In all laboratory work on bodies, materials have been ground separately, and then proportioned by volume. Using the same proportions as in the old mixing car system, we have not been able to check laboratory shrinkage results with the shrinkage results of the body prepared in a larger way. Our total shrinkage values in general have varied from 4.20% to 4.60%, in comparison with the average value of 6.66% in actual practice.

On the other hand when the proportions of the new system have been used in laboratory work, the shrinkage results have been very nearly the same as in actual practice. For example, the large shrinkage trials for a period had an average total shrinkage value of 6.91% and an average moisture content of 26.3%. At this time some laboratory trial pieces which were made had an average total shrinkage of 6.83% and a water content of 26.3%.

Therefore when the bulk method of proportioning is used, laboratory shrinkage results may be made to check fairly closely with actual practice, by finding the volume changes which occur with the constituents in reducing them from coarse to finely ground materials, and making corrections in the composition accordingly.

Effect of Water on Shrinkage

In attempting to discover the causes of variation in shrinkage, the effect of variable amounts of water has been noted. An average figure for water content for our terra cotta body is 26%, based on dry weights. The body mixture on this basis has a total linear shrinkage of 6.8%, fired at cone 4. In checking the per cent moisture in the body, samples have been taken from the same wads of terra cotta body used for pressing shrinkage trial pieces, and at the time they were pressed. A variation of from 25.2% to 29.0% water content has been noted in one day, and the total shrinkage of the two trial pieces was 6.07% and 7.04% respectively.

In order to be sure that such variation was not largely due to variation in the character of the clay, we have taken dry terra cotta body, mixed it thoroughly, and tempered with different percentages of water. In one such experiment with water contents 24.5% and 27.0% there resulted total shrinkages of 5.82% and 6.66% respectively fired at cone 4. At another time with 22.1% and 27.5% of water there was a total shrinkage variation of from 5.21% to 7.02% respectively, fired at the same temperature. These values were the average of eight 1″ x 1″ x 8″ shrinkage bars.

There is some variation due to the character of the clay, but the data indicate that if an accurate method of control of water content could be devised, our shrinkage problems would be measurably simplified.

GLADDING, MCBEAN AND CO.
LINCOLN, CALIF.

THE USE OF RADIATION PYROMETERS ON REFRACTORY KILNS[1]

By Charles B. Thwing

ABSTRACT

The high cost of maintenance of platinum thermocouples has greatly discouraged the use of pyrometers on kilns firing silica and other high refractories.

The method of using a combination recorder employing thermocouples for the lower ranges of temperatures and the radiation pyrometer for the higher ranges is described.

The accuracy of the measurements is fully equal to those made with platinum thermocouples at a temperature for which the latter are durable, and the radiation pyrometer has the advantage of not deteriorating at high temperatures.

Neither couple nor radiation tube is damaged by removal while hot, so that the tubes may be kept in constant service, thus making the cost of the complete installation very reasonable.

The high cost of maintenance of platinum thermocouples has greatly discouraged the use of pyrometers on kilns firing silica and other high refractories.

About six years ago, at the request of O. M. Reif, Vice-President and General Manager of the Harbison-Walker Refractories Company, G. K. Slotterer, Superintendent of the Chester and Downingtown Plants of that Company sought the advice of the writer concerning the possibility of obtaining an efficient and economical pyrometer equipment for their silica kilns.

We worked out together the plan which was tested out for four years at the Downingtown plant.

The results obtained were so satisfactory that in 1923 the Company ordered at one time similar equipment for six additional plants covering ninety kilns.

The General Refractories Company also has ordered equipment of the same sort for one of its plants.

The radiation pyrometer is the same, with some improvements, as we have been using since 1908 on lime and cement plants and glass plants. It is not sensitive for low temperatures.

In order to cover all parts of the temperature scale from water smoking to finish with a chart having an open scale a two galvanometer recorder is used. One galvanometer records temperatures up to 1600° from a base metal thermocouple; the other records high temperatures from the radiation receiving tube.

Each galvanometer records two kilns, the records being distinguished by dash and dot. Each recorder is at one time recording two low and two high kilns.

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[1] This paper is preprinted for use at the Annual Meeting of the American Ceramic Society, Columbus, Ohio, February, 1925, and does not constitute a release to the press.

The mounting is designed primarily for the radiation tube but serves equally well for the thermocouple. It consists of a square refractory hollow block having an inside diameter of about 7 inches. The closed end of this muffle, which projects a few inches through the crown of the kiln is ground to a uniform thickness of $1^1/_2$ inches.

The top of the muffle is closed by a flanged cover having a circular hole through which the couple is inserted. When the recorder shows a temperature of over 1600° the thermocouple is disconnected and removed and the radiation tube put in position above the hole and connected to the same wires formerly used for the couple.

At the same time the necessary changes in the recorder connections are made at the plug switchboard in the pyrometer room.

The pyrometer mounting on the kiln is protected from the weather by our usual ventilated brick housing which also serves to smooth out the larger variations in the temperature.

When desired the block may be installed through the side wall, or the block may under some conditions be omitted and the tube pointed directly at the ware.

When the last mentioned plan is adopted it is well to provide a vertical blast of air in front of the opening to screen the instrument from occasional outrushing flames.

The accuracy of the measurements is fully equal to those made with platinum thermocouples at the temperatures for which the latter are durable. The radiation pyrometer has no upper limit of temperature. We have successfully measured temperatures above 4000°F in a tungsten furnace. The higher the temperatures the more efficiently the pyrometer functions.

Barring accidental breakage of the muffle, which can with care be forestalled, the radiation tube is not subject to damage and the interior of the tube is so sealed in that the calibration remains constant for a long period of time.

Neither couple nor radiation tube is damaged by removal while hot, so that the tubes may be kept in constant service, thus making the cost of the complete installation very reasonable.

President, Thwing Instrument Co.
Philadelphia, Pa.

A MICROSCOPIC STUDY OF STRESSES IN GLAZES[1]

By Arthur V. Henry

ABSTRACT

Stresses in glazes are studied making use of the microscopic method. The investigation indicates that differential coefficient of expansion is partially responsible for stresses in glazes.

There are several possible explanations which may account for stresses in glazes.

1. Seger in his "Collective Writings" attributes stresses ordinarily to the differential coefficient of expansion between the body and the glaze.
2. Since a glaze is not a homogeneous substance, there will be a differential coefficient of expansion between the various sections of the glaze itself.
3. A glaze in cooling tends to crystallize. A change in volume accompanies crystallization, bringing about stresses.
4. New compounds may form after the glaze has become rigid and introduce stress.

The following work was done in an effort to determine how much of the stress in a glaze was due to the differential coefficients of expansion between the body and glaze.

Theory

A glass is an amorphous substance and normally isotropic, *i. e.*, it will transmit light with equal velocity in all directions. If, however, the glass is subjected to a stress, it becomes anisotropic and a ray of light passing through it, will be broken up into two rays of unequal velocity. The difference in velocity of these two rays becomes greater as the stress increases. It has been proved[2] that the stress in a glass is directly proportional to the birefringence or difference between the indices of refraction of the two rays.

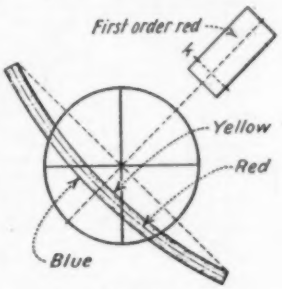

FIG. *A*.

The index of refraction of a substance is the inverse proportion of the velocity of light through the substance to the velocity of light through air, the latter being taken as one. The birefringence multiplied by the length is called the optical path difference, which quantity can be measured by means of a microscope and a compensated quartz wedge. The optical path difference $(n_a - n_b)l$, divided by the length of path is obviously the birefringence of the glass under test $(n_a - n_b)l$, where n_a = index of refraction of one ray, n_b the index of refraction of the other, and

[1] Recd. Jan. 13, 1925.

[2] L. H. Adams and E. D. Williamson, "The Relation between Birefringence and Stress in Various Types of Glass," *Jour. Wash. Acad. Sci.*, **9** [20], Dec. 4 (1919).

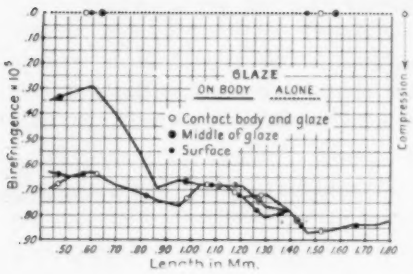

FIG. 1.

l the path length. The following curves represent a variation of birefringence or stress multiplied by a constant, throughout the length of the glaze.

A simple experiment can be made showing the effect of stress upon glass. If a narrow (one-half inch) strip of ordinary window glass is placed under a microscope at the 45° position between crossed nicols and bent slightly with the fingers the following reactions will take place when viewed through a selenite plate. The edge of the plate under tension will become blue; the center or neutral zone, red; and the edge under compression, yellow.

This theory was applied to the work on glazes.

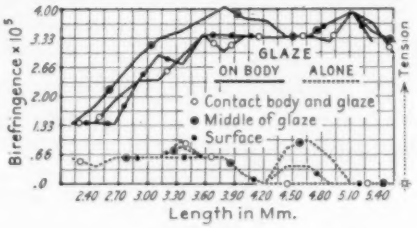

FIG. 2.

Method

A section of body and glaze was removed from tile, cemented to the end of a rotating stage and immersed in oil. The whole was then placed under the microscope between crossed nicols and the optical path difference of the ray of light passing through the length of glaze was read off on a compensated quartz wedge. The wedge was graduated in 10 $\mu\mu$ divisions and could be read with an accuracy of one division. Readings were taken at intervals along the glaze. The glazed test piece was then cemented to a glass plate with Canada balsam and the body ground off using emery powder and water. Similar readings at the same intervals were made and curves drawn. The extreme thinness of the glaze in Fig. 1 necessitated the use of a 16-mm. objective. A 32-mm. objective was used with the remaining glazes.

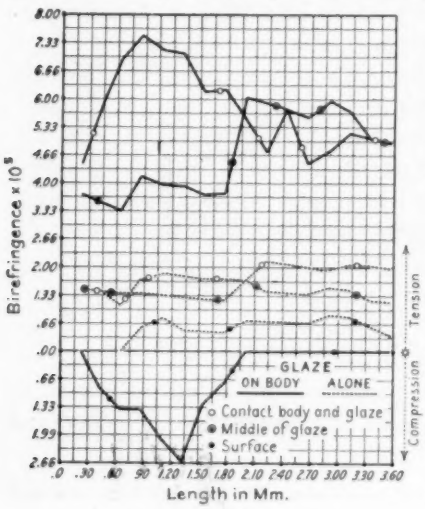

FIG. 3.

Figure 1 represents a commercial

glazed tile that showed no tendency to craze or shiver. The glaze is under a fairly uniform compression throughout. No stress was detected in the glaze after the body was removed.

Figures 2 to 9 represent tile glazed in the laboratory. All crazed badly. The glaze of Fig. 2 has the formula:

0.15 K_2O	0.20 Al_2O_3
0.15 Na_2O	1.0 SO_3
0.40 CaO	0.333 B_2O_3
0.30 PbO	

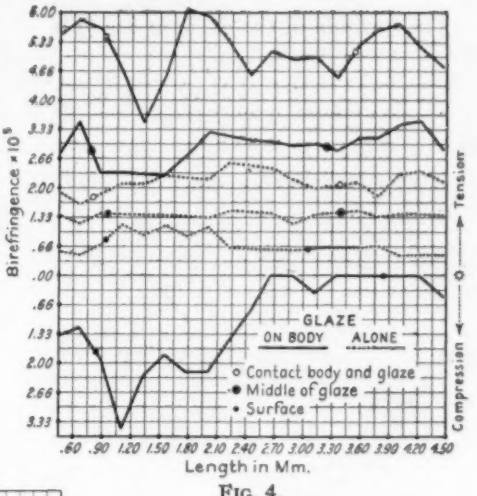

FIG. 4.

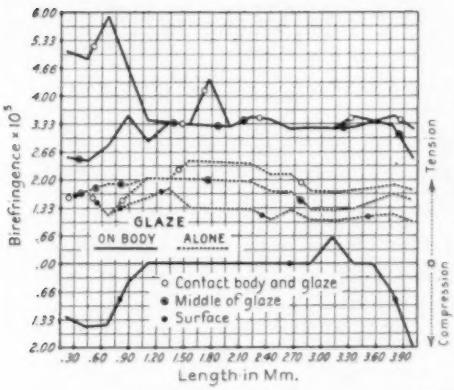

FIG. 5.

0.15 K_2O	0.20 Al_2O_3
0.15 Na_2O	1.33 SiO_2
0.40 CaO	0.44 B_2O_3
0.30 PbO	

fired to cone 05. The dividing surface between the body and glaze and the middle of the glaze shows a high degree of tension while the surface is under rather high compression. With the body removed the glaze shows a uniformly low tension.

Figure 4 is a test of another section of the same tile as Fig. 3, giving similar results.

and was fired to cone 5. On the curve, it is seen to be under considerable tension, somewhat greater in the middle of the glaze than either at the contact between the body and glaze or at the surface. The glaze alone shows slight tension.

Figure 3 represents a glaze of the formula

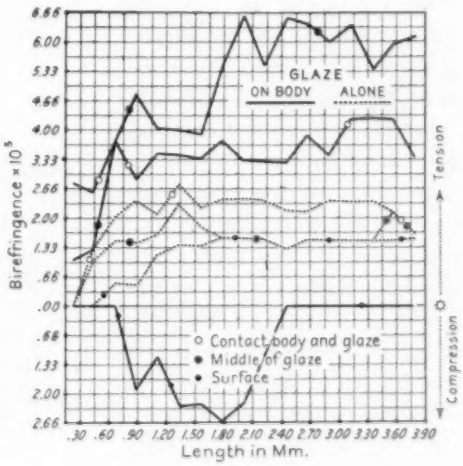

FIG. 6.

The formula of the glaze in Fig. 5 is

$$\left.\begin{matrix}0.15\ K_2O\\0.15\ Na_2O\\0.40\ CaO\\0.30\ PbO\end{matrix}\right\}\ 0.20\ Al_2O_3\quad 1.5\ SiO_2\quad 0.5\ B_2O_3$$

It was fired to cone 05.

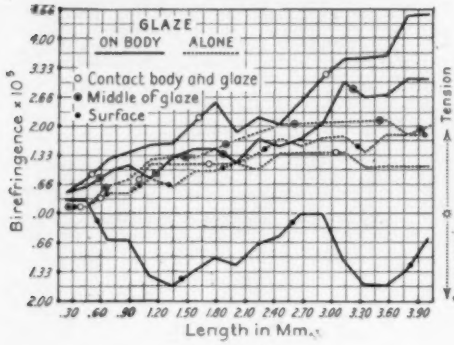

FIG. 7.

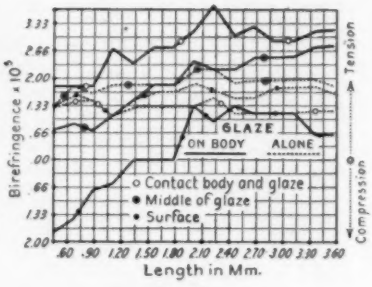

FIG. 8.

Figure 6 represents another section of the same tile as in Fig. 5.

Figures 7 and 8 are tests on glazed tile of same composition as those of Figs. 5 and 6 but fired at cone 1. These show less stress probably due to greater solution.

Figures 5*a*, 6*a*, 7*a* and 9 show how the stress varies from the point of contact with the body to the surface of the glaze. In the first three of the figures named, the stress (tension) increases approximately up to one-third of the thickness of the glaze and then decreases through a neutral zone of zero stress to a decided compression, except in Fig. 9. The fact that the stress is less at the point of contact than at one-third the thickness of the glaze, is probably due to the partial solution of the body by the glaze.

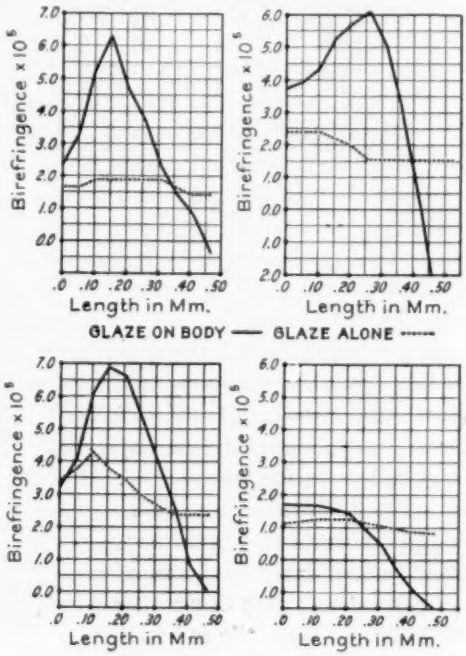

FIG. 5*a*, 6*a*, 7*a*, and 9.

Conclusions

The differential coefficient of expansion between the body and glaze is an important factor in causing stresses in glazes. Stresses are introduced to a less degree through other causes. It appears desirable to have a glaze under slight compression at room temperatures. Acknowledgment is made for the assistance and suggestions of Dr. Wm. McCaughey.

CERAMICS DEPARTMENT
OHIO STATE UNIVERSITY

MANUFACTURE OF REFRACTORIES BY DRY PRESS METHOD[1]

By Earl Hagar

ABSTRACT

A brief description of the manufacture of refractories by the dry press method is given emphasizing the following points in the preparation of materials: (*a*) weathering, (*b*) grinding and tempering, (*c*) screening, (*d*) mixing; the pressing of shapes and the amount of pressure is described. Six points are given as advantages of the dry press method, chief of which are reduction in cost of manufacture and increase of life of ware.

Both the manufacturers and users of fire brick and shapes are benefited by refractories made by the dry press method. Among numerous advantages, the cost of manufacture is greatly reduced, and the life of the ware is greatly increased.

Since the dry press process is comparatively a recent development, and some manufacturers are not yet familiar with its distinct advantages, the development and extension of the dry press method calls for an explanation of the special requirements and resulting advantages of its use.

The successful manufacturing of magnesite and chrome brick, and fire clay brick from non-plastic flint clays is evidence that it is both possible and practical to manufacture refractory shapes by the dry press method.

Preparation of Materials Important

Weathering

It is not the kind of materials used, but the method of preparation and pressing that brings results. Although a high percentage of plasticity is not essential for dry press ware, the best brick is produced with the least expense, trouble and loss when the plasticity of the raw material is developed. This should be done by weathering the raw material in storage piles, or by storing the freshly ground clay in a moist condition. In general, the clay should weather not less than forty-eight hours, but a greater length of time will be an advantage.

Grinding and Tempering

In grinding the material, any method may be used that will produce the fineness required. If by a dry pan the final amount of moisture may be admitted at the pan on the theory that if the full percentage of moisture is contained at this point, the grinding operation will have some of the beneficial effects of a wet pan and develop the full plasticity of the clay. However, any other method of mixing the water with the clay may be used that will distribute evenly the fine and coarse particles without causing the clay to form small, damp balls. These damp balls are detrimental to the mechanical operation of the press, and cause the product to be of a coarse nature. A common test to determine the proper condition of the material is to squeeze some of the material in the hand. If it balls up and stays

[1] Recd. Dec., 1924.

in a compact shape, and breaks without being shattered, it is in proper condition for the dry press. If, however, this hand pressure squeezes water out of the clay, it contains too much moisture, but in general, the higher the percentage of moisture without any excess, the better the ware. A mixture too dry produces poor corners and edges and when fired is usually soft and shells easily.

Screening The clay which goes through the pan or other grinder should pass through some type of screen. Although the percentage of coarse sizes in various clays is variable, it is very important that the percentage of finely ground clay be sufficient to fill the voids between the coarse particles. If the percentage of coarse particles is too large, the plasticity of the entire mass is greatly reduced even though the clay be classed as highly plastic. The grind or size of screen used must be determined from the clay used, to satisfy the needs of the consumer. In general, the fine grind works the better in the press and makes a stronger, denser and better appearing brick.

Mixing It is very essential that some form of mechanical mixer should be used just above the press to keep fine and coarse particles evenly mixed, being fed into the press through a perpendicular chute. A chute built at an angle will cause the coarse particles to run ahead of the finer ones, thereby destroying the uniform mixture. It is very important that an even, uniform mixture be maintained at all times if the best results are to be obtained. Whenever the moisture content changes, the amount of material and strength of bond in the product changes.

It is important, too, that the material used in the manufacture of large refractory shapes by the dry press method be uniform and homogeneous. Without this uniformity and homogeneity one may encounter serious difficulties in the manufacture of large shapes. The shapes would have an undue tendency to check or crack while drying, and it would also cause warping and cracking while firing. However, with proper care one should make shapes as large as 24 x 12 x 4 inches, or even larger without any serious difficulty.

Pressing of Shapes

There are a large number of shapes being used today that are practical sizes to be made by the dry press process; also various 9-inch sizes. To equip the press for making these properly is very important. One should have even distribution of material in the mold box according to the shape of the brick. For example, if it is a standard 9-inch No. 1 wedge, the mold must contain more clay at the thick end. This can be done successfully by means of a tapering device attached to the charging box that will cause the clay to be left in a tapered pile on the mold box. The same principle may be applied to arch brick, and all other difficult shapes.

The Amount of Pressure

The amount of pressure is important since upon pressure greatly depends the results of dry press brick making. This pressure at times equals five to six thousand pounds per square inch. The amount of pressure depends upon the class of the clay, and the amount of moisture. In some cases high plasticity will cause the ware to split or "pressure crack." The addition of grog or calcined material assists in overcoming this trouble. Dry pressing should be done under the highest pressure possible. High pressure causes the ware to split, but this trouble can be reduced by increasing the period of pressure. This may be done by cutting down the speed of the press, or it may be built in the machine mechanically. In general the greatest possible pressure produces the best brick.

Advantages of Dry Pressing

Some of the advantages to be gained by making brick and large shapes by dry press process are:

1. The cost of manufacture will be reduced.
2. The cost of installing expensive driers or dry floors will be lessened since standard sized brick and most shapes are sometimes set direct from the machine to the kiln.
3. The resultant ware will be more uniform and exact in size, which is very important in construction of furnaces.
4. The refractoriness of some clays will be increased.
5. The uniform size of ware will reduce the fire clay used in the joints.
6. Large refractory shapes, made by the dry press process are able to withstand sudden changes of temperature much better than shapes made by any other process.

Therefore, refractory manufacturers and refractory users should investigate thoroughly the use of fire brick and large shapes made by the dry press method, thereby reducing cost of production, and in turn giving their customers the very best service possible.

WELLSVILLE, MO.

CERAMIC ABSTRACTS

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[1] The abbreviation (*C. A.*) at the end of an abstract indicates that the abstract was secured from the editor of *Chemical Abstracts* by coöperative agreement.

Art

A new Coptic vase. ANON. *Bull. Metropolitan Museum of Art*, May, 1924.—There has lately been added to the Egyptian collection of the Museum, a large Coptic earthenware vase of unusual artistic and archeological value. The vase is unglazed but richly decorated in horizontal bands. The colors are orange-yellow and black-brown over a white engobe. The decorations represent the life of birds and animals, only one coarsely drawn human figure appearing on the vase. The decorative elements of the vase are partly based on the Egyptian love for the Nile landscape with its innumerable fishes, birds and animals amid lotus and papyrus stems. These subjects were retained by the Christian Egyptians and were employed by the Copts both in textiles and in other mats. In comparing the decoration and the arrangements of motifs on this vase with those of the Coptic paintings one finds a great similarity. The development of Egyptian art in the Roman and Byzantine periods shows two different styles: Hellenistic, from the 1st century A. D. until the end of the 4th century A. D., with naturalistic treatment of the motifs; and Coptic, from about the beginning of the 6th century A. D. until the beginning of the 9th century A. D. where the polychrome decorative appearance of the motifs was the main artistic principle. The Copts neglected the study of the proportion and form of the human figure. Coptic art was influenced by the Persians when Egypt was a Persian Province and later when the Arabs conquered Egypt, it became an important center of Arab art. In the beginning the Arabs were very tolerant of the Copts and Coptic art flourished until the 9th century, when the Arab influence finally changed the character of Coptic art from polychrome-decorative to linear. Naturalistic forms were replaced by conventionalized ones, partly derived from Persia. Many of the details of one vase are of Persian origin and not Egyptian and were taken from Persian textiles popular in Egypt during the Arabic period. The 8th century A. D. marks the end of Coptic art and the beginning of the new Arab style with many Persian elements. The new vase probably belongs to this century.

Microscopic structure of the surfaces of mat glasses. K. HESSE. *Sprech.*, **57**, 614(1924). H. G. S.

Cement, Lime and Plaster

Some facts about Portland cement manufacture. CHARLES WADSWORTH. *Chem. Met. Eng.*, **31**, 570–3(1924).—A description of the plant of the Petoskey Portland Cement Co. The wet process is used. Power is furnished by waste heat boilers. Raw mats. are ground in Allis-Chalmers com. peb. mills, with a ball consumption of .35 lbs. per barrel of cement. M. E. M.

Some requirements in the study of Portland cement. THADDEUS MERRIMAN. *Eng. News Rec.*, **93** [3], 105(1924).—Outlines condition to be studied in developing better tests for cement and classifying different types. Gives characteristics of the ideal cement. F. G. J.

New lime burning plant of Union Carbide Co. H. L. NOYES. *Eng. News Rec.*, **93** [14], 546(1924).—Describes 3 rotary kilns, 8 ft. diam. 125 ft. long, each discharging into a rotary cooler 5 ft. diam. 50 ft. long, fired with pulverized coal. F. G. J.

Effect of alkali soils on concrete structures. G. M. WILLIAMS. *Can. Eng.*, **45**, 587–8(1924).—Results of investigations in this problem which has vexed the west parts of both Can. and U. S., carried on at the Univ. of Sask. Extended field work definitely fixes the fact that the disintegration is a chem. action, not a phys. disruption and further work will be in the nature of lab. research into the chem. reactions involved. A fund of $40,000 has been contributed by the Research Council of Canada, the prairie provinces and interested corporations for this purpose. Some of the results are briefly as follows: 1. Rapidity of disintegration varies directly as the sulphate concn. 2.

Concn. of salt in ground water may be extremely variable at points short distances apart. 3. Concrete of high quality is most resist. to action. 4. Drainage precautions help where the alkali conditions are bad. 5. Membrane waterproofing may prevent action for a time at least. 6. Port. cement, as now constituted, is inherently subject to attack by sulphates in the soil and ground water and the final soln. is dependent upon the discovery of some mat. which may be added to Port. cement to make it immune to such action. O. P. R. O.

Cement manufacture (Tasmania). ANON. *Jour. of Indus. and Min. Stand.*, **72**, 639(1924).—At the Railton Cement Works, a scheme, covered by patents, has been devised by E. G. Stone, whereby the waste heat from the rotary kiln, passing through the retorts, is used to extract oil from shale, large deposits of which are available in the vicinity. The process is generally termed that of "destructive distillation." The oil vapors issuing from the shale are drawn from the retorts by means of exhausters through various types of condensers. After all the oil has been so extracted the gas still contains a certain amt. of light spirit, which will again be extracted in scrubbing towers. One of these scrubbing towers will work under vacuum and the other under press. When the light spirit is extracted there still remains a large propn. of what is termed "fixed gas." At the outset S.'s patents cover the use of this gas for assisting to calcine the cement mixture into clinker, which is ult. ground to form cement. As there is not sufficient gas in the amt. of shale to be treated to calcine such cement mixt., the necessary amt. of heat will therefore be built up by using the poorer qualities of oil collected during the special process. O. P. R. O.

Yield of hydrated lime from air-slaked lime and magnesian limes. O. REBUFFAT. *Giorn. Chim. Ind. Appl.*, **6**, 328–30(1924); *Jour. Soc. Chem. Ind.*, **43**, B871(1924).—An app. is described for measg. the yield of lime paste (vol. for a given weight of dry subs.) obtainable from air-slaked lime. The yield is not appreciably diminished by magnesia, even in large propn., but is lowered considerably by small amts. of silica or alumina. H. H. S.

Potash from cement dust. Concentration by elutriation. E. J. FOX AND C. W. WHITTAKER. *Ind. Eng. Chem.*, **16**, 1044–6(1924). H. H. S.

Solubility of Portland cement in weathering agents. H. K. BENSON, J. S. HERRICK AND T. MATSUMOTO. *Ind. Eng. Chem.*, **16**, 1063–6(1924). H. H. S.

PATENTS

Cement or waterproof glue material and process of preparing or manufacturing the same. HENRY L. HASKELL. U. S. 1,516,567, Nov. 25, 1924. The process of prepg. a cement consisting of prepg. a soln. of blood albumin in water in the propn. of about 55% of water to 45% of albumin, thoroughly admixing the same, adding thereto a heavy grade of silicate of soda in the propn. of about 9% by wt. of the dry disodium silicate to the albumin content, and mixing the same until the mass becomes of a homogeneous syrupy consistency.

Iron-containing cements. BRITISH PAT. 222,122, 1924. A cement is made by burning a mixt. contg. iron oxide and calcium carbonate, at a temp. below the m. p. of the mixt., the propns. of the mixt. being more than 2 mols. of calcium carbonate to each mol. of iron oxide, and one mol. of lime for each mol. of alumina, and 2 mols. for each mol. of silica, if these compds. are present. Suitable raw mats. are iron pyrites, cinders, iron ores, ochers, and sludge from alumina foundries. According to an example 160 kilos. of pyrites cinders and 300 kilos. of limestone are mixed wet or dry, and fired in a rotary or other kiln at a temp. of about 1100°C. O. P. R. O.

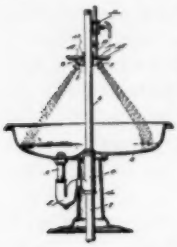
Low-temperature cement. H. KÜHL. Ger. Pat. 399,446, July 5, 1923. *J. Soc. Chem. Ind.*, **43**, B911(1924).—A mixt. of mats. contg. lime and clay together with a small percentage of fluorspar, the lime content being intermediate between that of Port.

cement and Roman cement, is heated to a temp. slightly above that required to expel CO_2. The product is said to possess better storage qualities than the corresponding Port. cement. H. H. S.

Enamel

PATENTS

Enamel composition. HUGH S. COOPER. U. S. 1,517,618, Dec. 2, 1924. An enamel compn. contg. zirconium oxide and an opacifying compd. of a metal having an atomic wt. of about 119, in about the propn. of three wts. to two.



Washbasin. DAVID A. EBINGER. U. S. 1,517,414, Dec. 2, 1924. A device of the class described comprising a basin, a vent pipe rising centrally therefrom, a manifold adjustably carried by the vent pipe and having a soap container associated therewith, and means for introducing water into the manifold.

Glass

River Rouge automobile plate glass factory. J. WILSON ROBINSON. *Eng. News Rec.*, **93** [10], 376(1924).—Lighting and ventilation controlling factors. Annual capacity 10,000,000 sq. ft. automobile glass. Conveyor systems make everything automatic. Four tank furs. built of large fire-clay blocks tied together. Four regenerators on each fur. Outer walls of fur. cooled by air blasts. Temps. 2450°F charging end, 2150°F discharging capacity 250 T. each. F. G. J.

The present position of the glass industry in North America. W. E. S. TURNER. *Jour. Soc. Chem. Ind.*, **43**, 1086(1924).—The cut-glass industry has almost died out in America, but colored glass is more and more finding a place. Pot furs. are being displaced by tank furs. which are used even for manuf. of green and blue signal lights, for selenium ruby glass and for elec. light bulbs. There has been a distinct development in the use of blowing machs. or press and blow machs. Reference is made to the Westlake mach. for thin-walled tumblers and the Hartford-Empire mach. for elec. light bulbs. The opern. of sheet glass at the Ford Motor Works is described as epoch-making. Dealing with the problem of fur. efficiency, a table is presented showing for a number of factories the value of the ratio of fuel consumed to glass melted. Several factories could show ratios as low as 0.6. Finally a description is given of heatless leers. H. H. S.

The production of colorless glass in tank furnaces, with special reference to the use of selenium. IV. The influence of arsenious oxide. A. COUSEN AND W. E. S. TURNER. Meeting of Soc. Glass Tech., The Univ., Leeds, Nov. 19, 1924.—Previous work by the authors had shown the great influence of arsenious oxide in preventing the development of color in a selenium decolorized glass. It was evident that some of the effect was due to the action of the oxide upon the iron present. In confirmation of this fact meltings of a glass batch with addn. of various quantities of arsenious oxide were made, and the color of the glass was found to be less the more of the oxide there was in the batch. This then was the first important effect of arsenious oxide in decolorizing, the second consisted in the suppression of the brown selenium color. From this point of view selenium and cobalt oxide were only secondary mats. in the decolorizing process. The pink color due to selenium was developed at the commencement of melting. For its successful production it required a hot fur. for the first stages of melting, and a low iron oxide content of the glass. An attempt to replace arsenic by its equivalent of phosphorus in the form of calcium phosphate showed the latter substance to have little or no effect upon the brown selenium color. Antimonious oxide used instead of arsenious oxide with selenium gave a deep bluish green color. The cobalt oxide

required in decolorizing was about $^1/_{12}$ oz. per 1000 lbs. of sand, and this quantity could not be increased by 50% without producing a distinct blue color in the glass.

A note on some properties of a sandstone block after use in a glass furnace. H. S. HOULDSWORTH. Meeting of Soc. Glass Tech., The Univ., Leeds, Nov. 19, 1924.—In the expts. described refrac. mat. (Penshaw stone) and glass were ground separately until they passed a 100-mesh I. M. M. sieve, and were then thoroughly mixed in the desired propns. A little gelatine soln. was added, and cones were shaped from the mixt. These were then htd. alongside standard Seger cones in a gas-fired lab. fur. The results obtained indicated that powdered Penshaw stone interacted as readily with a soda-lime glass as did powdered or good fire-clay brick. Penshaw stone developed a close compact structure when used in a glass fur. This tended to hinder the penetration of glass into the stone, thus adding to the life of the refrac. and pointing to its successful use in fur. construction.

A striking instance of fire-clay corrosion through the action of saltcake. W. E. S. TURNER. Meeting of Soc. Glass Tech., The Univ., Leeds, Nov. 19, 1924. During the emptying of a glass tank, with the gas flame still running, the fire-clay blocks surrounding the dog-hole in a bottle-glass fur. began to swell and to flow, soon after they became exposed to the action of the flame, as the tank was drained. There was a suspicion that when the tank was started a charge of saltcake had been put into the dog-hole, under the belief that the blocking of the hole would be prevented. After examn. it was found that the exposed portion of the bocks had absorbed saltcake at an early stage in the opern. of the fur. and being covered with glass and the dissociation temp. very high, the saltcake had remained unattacked until contact with the flame during the emptying of the tank brought about decompn.

Note on the glasshouses of the Leeds district in the 17th, 18th, and early 19th centuries. FRANCIS BUCKLEY. Meeting of Soc. Glass Tech., The Univ., Leeds, Nov. 19, 1924.—John Houghton, writing in 1691, stated that there were then 3 glasshouses in Yorkshire, one near Ferrybridge, and 2 near Silkstone. They could now identify these as the glasshouses at Houghton, Bolsterstone and Silkstone. Henry Fenny was in possession of the Glass Houghton factory in 1740, but by the end of the century the business had ceased. The glasshouse at Rothwell Haigh was erected before 1726. A good description of it appeared in the *Daily Post* for March 10, 1726. From the Rothwell Registers it was fairly evident that the firm who took the glasshouse in 1726 included Stourbridge glassmakers. The last actual mention of the glasshouse was in 1773. The only glasshouse actually in or near the town of Leeds in the 18th century was known as the Engine Glasshouse, and this was probably the factory that supplied all the ordinary needs of the town for the greater part of the 18th century. It could be traced between 1738 and 1770. The Engine Glass House might have been the present as well as the predecessor of the famous Hunslet Glass Works, though the connection had still to be proved. Between 1814 and 1861 at any rate, the Bower family had several factories here. The people of Leeds must have owed as much to this family in the 19th century as they did to the Fennys in the previous century. In 1883 they had 4 glasshouses at work, and no competition in the town itself. Just before 1850, however, there was a sudden increase in the glass concerns in Leeds and the surrounding district, especially in the neighborhood of Castleford. An early 19th century glasshouse at Thornhill Lees could be traced back to 1830. Here Noah Turner made flint glass until the glasshouse was taken over by the Kilners before 1847, and converted into a bottle works. There was a glasshouse also at Worsborough Dale in 1833, worked by William Usherwood, but in the following year Messrs. Wood & Perkes were found in possession, making cut glass.

Electrolysis of soda-lime glass. I. Evolution of gas and its relation to sorption

and conductivity. J. W. REBBECK AND J. B. FERGUSON. *J. Am. Chem. Soc.*, **46**, 1991–2002(1924). H. H. S.

Glass industry in Czecho-Slovakia. ANON. *J. Soc. Chem. Ind.*, **43**, 1141(1924).—Conditions continue favorable and exports to America and Gt. Britain remain at a high level, but Belgian competition is being felt. There is a tendency to develop the home industry and to become independent of imports. England re-exports Cz.-S. glass to Canada, S. America and China. The hollow glass trade is now working at 60% pre-war capacity owing to vol. of business with Eng., Japan and U. S. Manuf. of bottles is 50% larger than last year. H. H. S.

Molding and glass sands (Great Britain). DEWEY, BROMEHEAD, CHATWIN AND DINES. *Geol. Surv. Great Brit.*(1924).—The occurrence of easily accessible and large reserves of sand in every way suitable for molding led to the selection of Woolwich as the site of the principal arsenal in Great Britain. This sand varies through shades of gray to pale brown and contains sufficient clay to give it binding properties. The "Erith" or "Blackfoot" molding-sand is sent to all parts of Great Britain and to many foreign countries, and is said to be superior. Chem. anals. gives:

	Per cent		Per cent
SiO_2	95.21	MgO	Nil
Al_2O_3	2.43	K_2O	0.89
Fe_2O_3	0.42	Na_2O	.19
CaO	.19	Loss on ignition	.88
		Total	100.21

The mech. anal. indicates that the grade of "fine sand" is dominant, it contains 95.8% of grains that are greater than 0.1 and less than 1 mm. As to min. compn., the detrital mins. are fairly abundant and occur in angular grains. Ilmenite (altering to leucoxene) and limonite, zircon and rutile abound, and tourmaline, ataurolite, and flakes of muscovite are also found. O. P. R. O.

Notes on the mixing of ingredients for glass. J. VOGEL. *Sprech.*, **57**, 624–6 (1924). H. G. S.

German raw materials for the glass industry. HUGO KÜHL. *Sprech.*, **57**, 622–4 (1924). H. G. S.

Review of the durability of alkali lime glasses. GUSTAV KEPPELER. *Sprech.*, **57**, 617(1924). H. G. S.

Drawing glass tubes by machine. GEHLHOFF. *Sprech.*, **57**, 615(1924). H. G. S.

The physical chemical state of glass. W. EITEL. *Sprech.* **57**, 614(1924). H. G. S.

Resista glass for laboratory ware. ANON. *Sprech.*, **57**, 457(1924). H. G. S.

Complete automatic glass blowing. WENDLER. *Sprech.*, **57**, 614(1924). H. G. S.

Observations of the elasticity and strength of glass. O. GRAF. *Sprech.*, **57**, 614 (1924). H. G. S.

Construction and operation of a new glass furnace. H. KNOBLAUCH. *Sprech.*, **57**, 614(1924). H. G. S.

Discussion of article entitled "Resista glass for laboratory ware." *Sprech.*, **57**, 627(1924).—This is a discussion of the article published in *Sprech.*, **57**, 457(1924). H. G. S.

The Austrian glass industry of 1923. ANON. *Sprech.*, **57**, 630–1(1924). H. G. S.

Australian glass manufacture, a progressive enterprise. ANON. *Indus. Aust. and Min. Stand.*, **72**, 351(1924).—A description of the Spotswood works of the Aus.

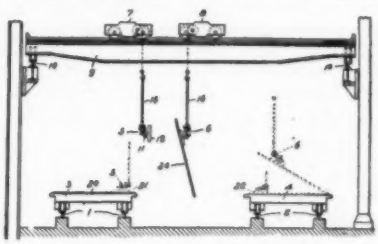
glass manufacturers is illustrated; bottle-making process is described; machines working absolutely automatically perform every operation connected with the production of a first-class bottle. Skilled labor is rapidly being supplanted by the use of machinery, thereby lessening cost and time for production. Glass insulators are also manufactured, and the manufacture of sheet glass is under consideration. O. P. R. O.

Volumetric glassware regulations. Slight change in units recommended. NAT. PHYS. LAB. *Chem. Age*, **11** (273), Sept. 6(1924).—Substitution of the milliliter for the cc. as the unit of vol. Changes in tolerance, ±0.06 ml. for a 50 ml. burette Class A as against ±0.04 cc. heretofore and 0.1 ml. for a 50 ml. graduated pipette Class A as against ±0.04 cc. E. J. T.

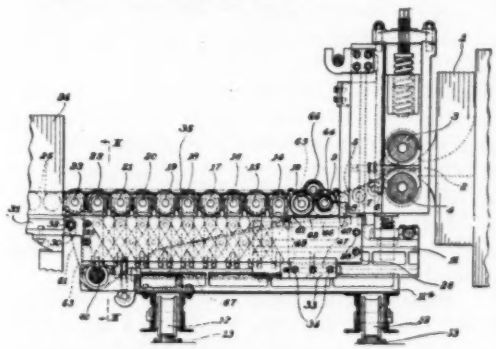
Standardization of scientific glassware. ANON. *Chem. Age*, **11** (274), Sept. 13 (1924).—Recommendations of the Joint Committee working under the aegis of the Institute of Chemistry, on the question of units of vol. and standards of accuracy. E. J. T.

PATENTS

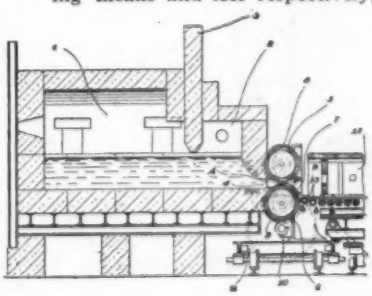
Process and apparatus for handling glass plates. JOHN H. FOX. U. S. 1,519,248, Dec. 16, 1924. In combination in app. for transferring a glass sheet from one car or carrier to another car or carrier and turning it upside down, which comprises a pair of vacuum lifting frames supported from above so that they may be given a movement of approach and also moved laterally over the tables, and means for raising and lowering the frames, each frame being pivotally supported so that it may face either downwardly or laterally.



Roller table for glass machines. ALBERT E. EVANS. U. S. 1,519,244, Dec. 16, 1924. The combination with means for continuously forming a ribbon of glass, and a leer in alignment therewith for receiving it, of an intermediate roller table, comprising a plurality of spaced rolls, a slideway extending under the series of rolls at each end, bearing members for the rolls slidably supported on the slideways, means for fixing the end bearing members with respect to the ribbon forming means and leer respectively,

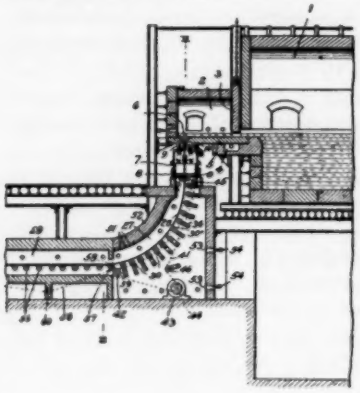


and lazy tong connecting means between the end bearing members and the other bearing members whereby the spacing between the rolls carried by the bearing member is maintained uniform as the end bearing members are moved in and out.



Apparatus for making sheet glass. WALTER G. KOUPAL. U. S. 1,519,314, Dec, 16, 1924. In combination with a tank adapted to carry a bath of molten glass, and having an outlet through one of its walls, and a pair of driven

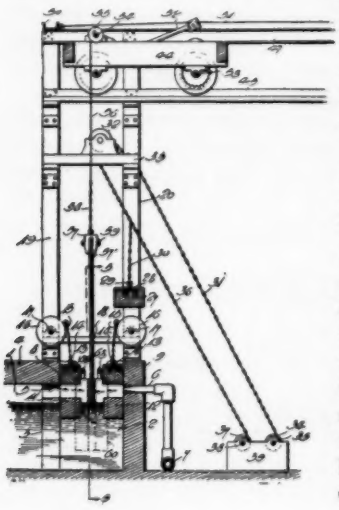
rolls having reduced end portions with shoulders at the juncture of said reduced portions and the body portions of the rolls, hollow metal closure members at each end of the rolls fitting between said reduced portions and abutting said shoulders and closing the triangular spaces at the ends of the body portions on the inlet sides of the rolls, and means for supplying a mixt. of gas and air to the interior of said closure members.



Process and apparatus for making sheet glass. HALBERT K. HITCHCOCK. U. S. 1,519,259, Dec. 16, 1924. In app. for forming sheet glass, a glass container adapted to carry a bath of glass therein provided with a refractory bottom with an outlet slot therethrough, a pair of rolls adjacent said slot, means for cooling the rolls, and a curved guideway below the rolls for receiving the sheet formed between the rolls and carrying it laterally, the said guideway being positioned such a distance below the rolls that the surface of the sheet may harden beyond the marring point before it reaches said guideway. The process of forming a continuous glass sheet or ribbon which consists in flowing it vertically from a bath of molten glass, passing the sheet through a cooling aperture to reduce it to a uniform thickness, permitting the glass to stretch of its own weight and engaging the sheet after it has hardened beyond the marring point and guiding it laterally into a leer.

Muffle leer. ALVIE C. CRIMMEL. U. S. 1,517,890, Dec. 2, 1924. The combination of a non-metal leer and a plurality of independent removable metallic units serving as muffles therefor and having openings in their opposite portions adapted to serve as either inlet or outlet openings and means for bracing said metal units.

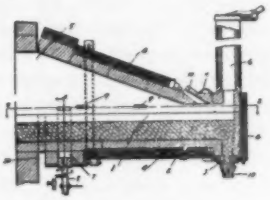
Glass sponge and process of making same. AXEL E. BERTELSON. U. S. 1,515,653, Nov. 18, 1924. A process of making a sponge-like product which comprises mixing glass wool with a salt which is substantially inert to glass, htg. sufficiently to sinter the glass, cooling and leaching out the salt. A sponge-like structure composed of a mass of numerous filamentous pieces of glass, sintered together at the points of contact with each other.



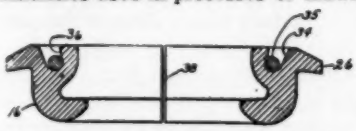
Sheet-glass machine. PRINTISS M. SELLERS. U. S. 1,515,625, Nov. 18, 1924. In a sheet glass making mach., a fire pot including an auxiliary chamber having an open upper end and communicating with the main body of the fire pot above the normal glass level, burner nozzles extending through the outer wall of the auxiliary chamber, supports positioned upon opposite sides of the auxiliary chamber, valve bars resting upon the supports for shutting the nozzle receiving opening of the outer wall and shutting off communication of the auxiliary chamber with the main body of the fire pot above the glass level, a cover bar resting upon the valve bars and closing the space between the same, means for swing-

ing the cover and valve bars upwardly to an open position, and means for drawing a sheet of glass out of the auxiliary chamber with the cover bar raised and the valve bars in an operative position, the valve bars when raised admitting ht. upon opposite sides of a sheet of glass to sever the sheet from the body of melted glass in the auxiliary chamber.

Method and apparatus for delivering viscous glass. OLIVER M. TUCKER AND WILLIAM A. REEVES. U. S. 1,516,220, Nov. 18, 1924. A spout for delivering viscous glass from a fur. comprising a trough with a delivery opening therein, an outer lining for said trough, said lining being spaced from the fur. wall to provide a space open to the atmos. between said lining and the fur. wall, and openings through said lining leading into said trough above the level of the glass therein for the introduction of a temp. modifying medium to the spout.

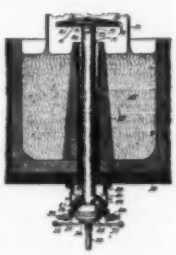


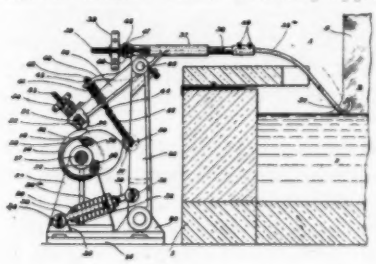
Glass-drawing bait and holder for glass-drawing machines used in processes of drawing glass. HECTOR BAZIN. U. S. 1,516,136, Nov. 18, 1924. A combination of a bait for drawing glass, comprising a continuous element, sectionally constructed, and a tension or spring member holding said sections in contact with each other and in contact with glass novel. In a glass drawing head, a pivoted lever with a bait supporting surface, and a surface adapted to limit the pivotal motion of the said lever, by contacting with the said drawing head, and a surface adapted to receive a thrust force operg. said lever to a bait supporting position, and a surface adapted to receive a thrust force operg. said lever away from a bait supporting position.



Process in frosting glass and composition to be used therein. CLARKE C. MINTER. U. S. 1,518,807, Dec. 9, 1924. A compn. for forming a substantially colorless translucent frosting upon glass consisting of a water sol. silicate, water, and glass in finely divided particles. A process of frosting glass articles comprising directing a water sol. silicate having suspended thereon finely divided particles of glass across the surface to be frosted, to entirely cover said surface to be frosted with a film of said soln. having disseminated therethrough said particles of glass or the like, exposing said glass article to contact of said film of said solution with the air to cause the formation of a solid film from said soln., and after the formation of said solid film washing said surface with water to remove any water sol. residue.

Art of drawing glass. ROBERT L. FRINK. U. S. 1,518,734, Dec. 9, 1924. The method of producing hollow glass articles which consist in drawing a hollow cylinder from a bath of molten glass and subjecting the walls of said body to an internally exerted substantial kinetic thrust uniformly applied around said walls below the point of congealing or setting thereof, and simultaneously cooling the same.





Edge holding device for sheet glass. JOHN H. FOX AND JOSEPH H. REDSHAW. U. S. 1,519,247, Dec. 16, 1924. In combination with app. for drawing a glass sheet from a molten bath, a lever arm mounted for swinging movement toward and from the sheet in

a vertical plane, a second lever mounted on the first lever transversely thereof for swinging movement also in a vertical plane, a pair of fingers spaced apart to straddle the edge of the sheet and carried by said second lever, a cam for swinging each lever, a pair of screw adjustments, including threaded stems and hand wheels carried by the second lever, one for moving the fingers toward and from the sheet, and the other for swinging it about its support on the first lever, and means for rotating the cams.

Heavy Clay Products

New asphalt filler for wire-cut brick roads. ANON. *Eng. News Rec.*, **93** [20], 797(1924).—Adoption of wire-cut brick on state roads in Ohio has required a new formula for asphalt filler. This is given. Tests show full penetration of the close joint. F. G. J.

Should drain tile be porous or vitreous? ANON. *Tonind. Ztg.*, **48,** 1115–6(1924). H. G. S.

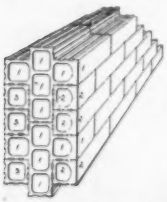
Exit the brick yard. H. H. WIKLE. *Chem. Met. Eng.*, **31,** 807–8(1924).—The Lake View Brick Co. of Chicago now uses city gas in updraft kilns. No cost figs. are given. M. E. M.

Vitrified tile liners used in Los Angeles sewers. ANON. *Eng. News Rec.*, **93** [5], 189(1924).—Vitrified tile liners are being used in all main trunk sewers in Los Angeles because it is believed they prolong the life of the sewers. In 50 mi. liners septic condition produces sulphuric acid which attacks concrete. Vitrified pipe is used up to 30 in. diam. F. G. J.

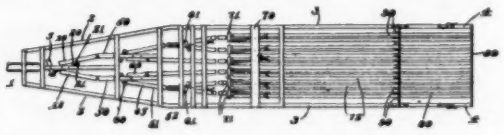
How can the spirit of craftsmanship be revived in the building industry? E. J. MELUEN. *Eng. News Rec.*, **93** [21], 837(1924).—A plea for good workmanship and a plan of procedure to attain it. F. G. J.

PATENTS

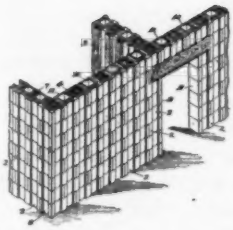
Hollow-tile building block. DAVID R. BONE. U. S. 1,516,491, Nov. 25, 1924. The cruciform building block of which the upright middle part is substantially 3 times as high as its lateral width and is formed with lateral extensions which are horizontally opposite to one another and are substantially equal in height and lateral extent to the lateral width of the said middle part, said middle part extending above the lateral extensions about one-half the distance of its lateral extent, said middle part extending below said lateral extensions about one and one-half times the distance of its lateral extent, substantially as shown, for the purpose specified.



Apparatus for automatically switching brick into plurality of rows for unit formation. ALEXANDER A. SCOTT. U. S. 1,516,409, Nov. 18, 1924. A switching device for controlling the passage of a plurality of brick in successive movement, consisting of means projecting into the path of movement of the brick, and partially displaced therefrom, in combination with additional means moved into the line of travel by a passing brick to complete the switching action of a third brick, whereby the passage of two brick are required to set the switch for disaligning a third brick, in combination with means resetting the switch to its original position by the passage of said third brick.



Interlocking building tile. MORRIS A. DAVIS. U. S. 1,516,473, Nov. 18, 1924. A building block having its longitudinal side faces provided with pockets from top to



bottom, one end of the block being provided with an interlocking rib and the other end with a set to receive a contiguous rib of an adjacent block in a wall course, each of said pockets being capable of receiving said contiguous rib, interlocking, tenon-like beads upon one longitudinal face of the block, and the opposite, longitudinal face having countersunk seats to receive the tenon-like beads of a contiguous block.

Brickmaking machinery. LAURITZ NEILSEN DYHRBERG. U. S. 1,518,641, Dec. 9, 1924. A brick forming apparatus including in combination a pugmill, a bar forming die associated therewith, a traveling cutting table for accommodating the bar, a stationary stand between the table and the die and adapted to be partially telescoped by the cutting table, a cutter for acting on the bar on the table, a brick cutting frame mounted on the table, a plunger for acting on the severed portion of the bar on the table for forcing the bar through the frame, a movable delivery table for receiving the cut brick, means for synchronously actuating the cutting and delivery tables and the plunger, and conveying means for receiving the brick from the delivery table.

Brick mold. GEORGE B. MENTZ. U. S. 1,519,150, Dec. 16, 1924. A brick mold of the kind described including, in combination, a base, sides attached thereto, a plurality of relatively thin partitions mortised into both the base and sides whereby the partitions are maintained against side distortion due to pressure, a plurality of outlet openings arranged in balanced relation to the space defined in the base by the sides and partitions, and threaded metallic caps protecting said outlet openings.

Refractories

Guide for choosing refractory material for industrial use. O. A. HOUGEN. *Sprech.*, **57,** 627–8(1924).—This is an abstract of an article which appeared in *Chem. & Met. Eng.*, **30,** 737(1924). See *Ceram. Abs.*, **3** [8], 246 (1924). H. G. S.

Refractory materials (Great Britain). F. R. ENNOS AND ALEXANDER SCOTT. Special Rep., Mineral Resources of Great Britain. *Geol. Surv.*, **28** (1924).—Refrac. mats., fire clays, analyses and phys. tests. Occurrence and distribution of British fireclay refrac. are described. Chem. and mineralog. compn. discussed, with changes during firing and the effect of impurities on properties. Methods of analysis employed, and analyses of chem. compn. of fire clays given. Phys. tests on fire clays, methods of testing and results of tests are given. Analyses—refractoriness in relation to chem. compn.; phys. tests—effect of load on refractoriness; firing, relation of porosity and contraction are discussed. O. P. R. O.

Investigation of firebrick for use in gas manufacture. CLAUDE C. BROWN. *Gas Age-Record,* **54,** 459(1924).—An investg. of fire brick for the rate of heat absorbed in a certain length of time was reported and tests were made on silica, magnesite, carborundum, clay, and Sil-O-Cel for use in regenerators. Formulas for calcg. the heat absorbed were brought out and the exptl. results checked fairly well. Curves plotted of the results for various thickness of brick and for various brick as to the rate of absorption are given. S. S. C.

Bonding high-temperature refractories. R. C. GOSREAU. *Chem. Met. Eng.*, **31,** 696–8(1924).—This article deals with bonding mats. for grain and powder refracs. to be used as patching cements, or in making monolithic linings. A table is given of various refracs., the bonding mats. to be used with them and firing conditions. M. E. M.

PATENT

Graphite crucible. EDUARD RIETZ. U. S. 1,518,818, Dec. 16, 1924. The described crucible consisting of graphite and compds. of the titanium group of metals.

Terra Cotta

Greek terra cottas. ANON. *Bull. Metropolitan Museum of Art*, May, 1924.—Due to an abundance of good clay in Greece there has always been a great variety of clay objects as well as many vases. Recent acquisitions include a relief, 3 statuettes, 2 heads, a waterspout, 4 vases and a lamp, all interesting pieces and several of unusual merit. In the collection of Tanagra terra cotta statuettes, a nude Aphrodite untying her sandal is a particularly graceful example of a type created in the 4th century B. C. and in favor for a long period. A draped woman in dancing posture, said to be from Trebizond is another attractive piece and it is full of interest for the study of Greek drapery. The Greek feeling for construction and for seeing things as a whole is evident even in this little figure. A group of a teacher with his pupil is an excellent example of the later realistic figures of the 3rd and 2nd centuries B. C. The teacher is entirely absorbed in his task of engraving letters for his little pupil who stands by his side. The figure of the man is beautifully modeled and the whole group is very lifelike. The upper part of a female figure in relief is a piece of beauty and importance, dating from the late archaic period. She is represented as wearing a polos, a chiton, and a sort of cape with openings for the arms; her hands are brought to her breasts, and between the left thumb and forefinger she holds a lotus bud. The piece was pressed in a mold and painted, the white for the flesh and black for the hair are still quite well preserved. The relief was probably a votive object, being hung up in a sanctuary, for in the back there is a hole for suspension. There are a number of similar "masks" as they have been called. One in the Museo Chigi at Sienna is almost identical with this one and there has been much discussion regarding their significance. Apparently they are a survival of the worship of the great nature goddess inherited from Crete and the East, and incorporated in the religion of classical Greece in the person of Demeter. A vase in the form of 3 cockel shells is another beautiful piece and dates from the best period of Athenian vase painting, for the mouth and handles are covered with black glaze of good quality. The shells are very naturalistic with ridgings and markings beautifully rendered and it is well preserved. A similar piece with a different grouping of shells was found at Eleusis and is now in the Museum there. Only the top of it is preserved and this bears the signature of the potter, Phintias. Possibly this one was made by him also. Two heads are interesting products of Greek fictile art at different epochs. One of a woman in the archaic style of the 6th century B. C. with conventionalized hair, protruding eyes and upturned lips, the other a brightly colored head of a man with a wreath and fillet, modeled in the realistic manner of the later Hellenistic art, much closer to nature than the archaic piece but without its remote, serene quality. A waterspout in the form of a lion's head is a good example of a Greek architectural terra cotta, dating probably from 4th century B. C. It is badly battered but enough remains for us to enjoy the fine strong modeling. Three terra cotta vases show the miscellaneous character of Greek ceramics after the 4th century B. C. One is a "Calenian" black-glazed bowl, with a frieze in relief of 4 chariots with victories and divinities, Athena, Herakles, Ares, and Dionysos; perhaps a representation of the apotheosis of Herakles. On the wheel of Dionysos' chariot are the letters L. E., probably the potter's stamp. There are 2 bowls with identical reliefs and 2 are in the British Museum, probably all made from the same mold. Our new one is one of the sharpest impressions. A black glazed plate with stamped, incised and painted decorations of rosettes, wreaths and dots belongs to same ware as table service

found in a tomb at Teano. This new plate is said to have come from Teramo. A buff spindle-shaped vase with inscriptions of white letters on black bands is typical product of the Roman period, as also a lamp with as many as 12 nozzles and a ring handle. A. A. A.

White Wares

Manufacture of high voltage insulators. M. H. HUNT. *Chem. Met. Eng.*, **31,** 729–32(1924).—A gen. description of the manuf. of high voltage insulators as practised at the Westinghouse Co.'s plant at Emeryville, Calif. M. E. M.

Beryl. ANON. *Indus. Aus. and Min. Stand.*, **72,** 387(1924).—Opaque beryl, until recently, was considered to possess practically no commercial possibilities, although small amts. have been occasionally used in Ger. for the manuf. of beryllium salts and metallic beryllium, said to alloy with iron, forming beryllium steels, possessing very desirable properties. When beryl is substituted for feldspar in the manuf. of porcelain in amts. varying from 25% to 45% of the total mixts., the other components being silica and clays, a product is obtained which displays a very high electrical resistance and low thermal expansion. This porcelain is therefore considered very promising mat. for electrical uses. Due to scarcity of beryl there has been no commercial production of this type of porcelain. O. P. R. O.

Feldspar (Victoria). ANON. *Indus. Aus. and Min. Stand.*, **72,** 474(1924).—The recent discovery of feldspar in the north-east dist. of Victoria is of great interest to Australian manufacturers of pottery and porcelain, who have had to import their requirements. Samples show it to be high grade and useful for glaze bodies. Prepns. are being made to open up the deposit on a large scale. O. P. R. O.

Chemical pottery. J. G. ROBERTS. *J. Soc. Chem. Ind.*, **43,** 1156–7(1924).—The greatest difficulty in the commercial production of chemical pottery lies in the varieties of shape and in the comparatively small number of any one type of article required. The methods adopted in manuf. vary according to the size and shape, those of small size and of circular form being produced on the wheel, those of large size being pressed or built-up, while the size of vessels made by casting is limited by the wt. of slip (100 gal. of slip weighs almost a ton), by the difficulty of getting the clay to stand up in the mold after removing the excess of slip, and by the cost of molds. A straight-sided vessel, such as a picric pot, has been cast up to 80 gal. capacity. Porcelain, composed of quartz, china clay, and feldspar or pegmatite, has sometimes ball clay added to it when large articles are made in order to increase the plasticity and strength of the unfired body. Manufacture is difficult, even when the chem. compn. is known, because of the obscure chem. and phys. reactions which are not allowed to go to completion. Variation of the physical condition of the ingredients leads to disaster. Thus all the α and β transformations of quartz, cristobalite, and tridymite, which take place below the m. p. are accompanied by a change of vol. Clay, again, when calcined to 1000° forms a crystalline sub. not yet identified. No good heat-resisting porcelain contains unchanged quartz but always the needle-shaped crystals which may be $Al_2O_3.SiO_2$ or $3Al_2O_3.2SiO_2$, sillimanite or mullite. H. H. S.

Equipment and Apparatus

Dry pans for grinding quartzite which discharge automatically. ANON. *Tonind. Ztg.*, **48,** 1116–7(1924). H. G. S.

How to find the contents of horizontal storage tanks. J. B. REYNOLDS AND S. COTTRELL. *Chem. Met. Eng.*, **31,** 665–7(1924).—The authors derive a formula for detg. the vol. of liquid in a horizontal cylindrical tank with convex ends, in which the radius of the ends equals the diam. of the tank. Two constants are used, and a table of these is given for different heights of liquid. The table is necessary to the use of the formula. M. E. M.

Are your sieves standardized? L. V. JUDSON. *Chem. Met. Eng.*, **31**, 822–3 (1924).—A plea for care in buying testing screens. Photographs of good and bad screens are shown. M. E. M.

How much does screen testing mean? R. B. LADOO. *Chem. Met. Eng.*, **31**, 623–6(1924).—The screen test is satisfactory for relatively coarse mat., but of little value for very fine mat. of which a large per cent goes through 300-mesh. Thus, of 2 mat., both of which were 90% through 300-mesh, one might be very much finer than the other. The author recommends photomicrographs of typical fields, using a calibrated net micrometer in the eyepiece, as a means of judging the fineness of extremely fine powders. The fact is noted that naturally disintegrated mats. have a much smaller average grain size than mats. disintegrated by grinding. M. E. M.

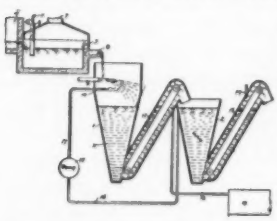
BOOKS

The Screening and Grading of Materials. J. E. LISTER. London: E. Benn, Ltd., 1924. Price, 6 s. H. H. S.

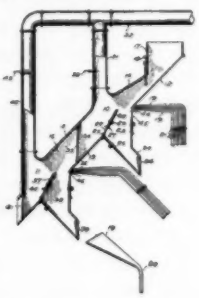
Crushing and Grinding Machinery. H. SEYMOUR. London: E. Benn, Ltd., 1924. Price, 6 s. H. H. S.

PATENTS

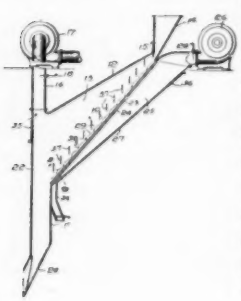
Process for the recovery of metallic values from slag. HARRY V. WELCH. U. S. 1,517,689, Dec. 2, 1924. The process of recovering metallic values from molten metallurgical slag, which consists in bringing said slag, while still molten, in contact with a halidizing agent in an oxidizing atmos. so as to form volatile compds. with a metallic constituent of the slag, collecting the mat. thus volatilized from the slag and subjecting the slag residue to leaching opern. to recover metallic values therefrom.



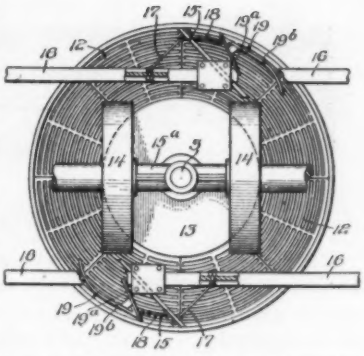
Pneumatic sizer. ALBERT H. STEBBINS. U. S. 1,517,595, Dec. 2, 1924. In a pneumatic sizer, in combination, a casing provided with separate closed chambers, means for delivering a jet of air into the first chamber, means for delivering a jet of air into the second chamber, partitions within said chambers in spaced relation to the respective jet delivery means, means for delivering mat. to be treated into the path of the jet of air in the first chamber that the lighter mat. may be carried by the air over the partition, means for directing the mat. falling upon one side of said partition into the path of the jet of air in the second chamber to further grade the mat. and means for preventing air from flowing from one chamber to the other.



Pneumatic sizer. ALBERT H. STEBBINS. U. S. 1,517,596, Dec. 2, 1924. A pneumatic sizer comprising in combination, a relatively long narrow casing supported at a longitudinal inclination, an apertured surface mounted within the casing and extending diagonally thereof at an increased inclination and forming oppositely flaring air chambers at the opposite sides of said surface, means for delivering the mats. to be treated to the upper end of the apertured surface, means at one end of the inclined casing for delivering air under press. to the under face of the apertured surface, means at the opposite end of the casing for exhausting air from the space above said surface and adapted to draw air from the upper portion of the apertured surface in approximately a horizontal direction, and upstanding baffles within said casing near the

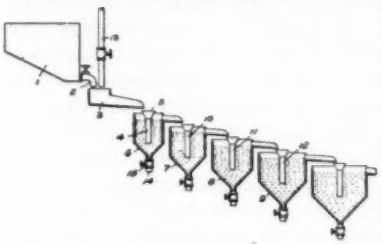


upper face of said surface and arranged to arrest the heavier particles carried laterally by the air.



Grinding mill. THOMAS E. BURNER. U. S. 1,515,654, Nov. 18, 1924. In a grinding mill, the combination with a rotating pan having a wearing surface and a grated bottom, of grinding members coacting with the wearing surface to grind mat., stationary members adapted to push the mat. beneath the grinding members with the rotation of the pan, plow-shaped scraping means floating on the grates, chain hitch connections between the scrapers and the stationary members.

Process for grading abrasives. FREDERICK GELSTHARP. U. S. 1,519,250, Dec. 16, 1924. The process of grading inorganic abrasives consisting in subjecting a mass of abrasive to a liquid flow in the presence of a deflocculating agent and collecting separate size grades of the abrasive as suspended thereby, the grains of the different grades being of substantially the same compn.



Kilns, Furnaces, Fuels and Combustion

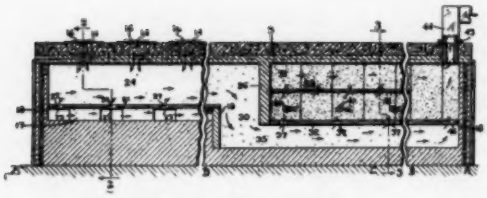
Coal and power. ANON. *Chem. News*, **129** (3661), Sept. 12(1924).—A discussion of the publication, *Coal and Power*, by the English Liberal Party, on the utilization of refuse mat. for fuel. E. J. T.

A lesson in modern manufacturing. ANON. *Chem. Met. Eng.*, **31**, 767–8(1924).—A description of the new tunnel kiln of the Vitrefrax Co., Los Angeles. The preheating zone is 33 ft. long. The firing zone is 25 ft. long, heated by 7 burners on each side in as many fire-boxes. The fire-boxes reflect heat directly against the ware. The cooling zone is 35 ft. long; the cooling ports are connected by flues to a blower that delivers cold air directly on the ware. Cast iron cars with roller bearing wheels are used. The car bottoms are cooled by a blast of cold air coming through ports in the floor of the tunnel and exhausting through arches built into the foundation of the kiln. Two classes of ware are fired; one which matures at cone 16, the other at cone 26. M. E. M.

Producer gas as an industrial fuel. D. J. DEMOREST. *Chem. Met. Eng.*, **31**, 578–81(1924).—The opern. of a gas producer, and the theoretical reactions taking place are described. It is only possible to obtain high temps. from such a lean gas, by the use of regenerators. Where a gaseous fuel is needed and there is room for regenerators producer gas is the cheapest fuel available. But whenever the direct burning of coal in any process accomplishes the desired result, producer gas is not economical. Hot, raw gas is better from the standpoint of heat efficiency, but in some operns., and whenever it is necessary to send the gas through mains, it should be cooled and scrubbed. Coal for use in producers should have low ash, high fusion temp. of ash (over 2300), 30–40% vol. mat. and contain very little fines. M. E. M.

PATENT

Tunnel kiln. THURE LARSSON. U. S. 1,517,437, Dec. 2, 1924. A tunnel kiln comprising a foundation and side and top walls forming a kiln chamber for the passage of ware, means for htg. the central zone of the kiln, means providing regulatable air



openings from the external atmos. into the interior of the kiln chamber which are spaced longitudinally of the cooling zone for varying the temp. curve thereof, and means for drawing air through said openings into the kiln chamber.

Geology

Potash deposits in Spain. A. MARIN. *Bol. Inst. Geol. España*, **4**, 44; *J. Soc. Chem. Ind.*, **43**, 1109(1924).—The potash basin in Catalonia is 26 miles long by 10 wide, and the potash is found between 600 and 2600 ft. The thickness of the bed is about 13 ft. It is calculated that 268 million tons of K_2O, equiv. to 2000 million tons of potash salts, are present at workable depths. H. H. S.

The physical chemistry of igneous rock formation. Joint meeting Oct. 22, London, of Faraday Soc., Geol. Soc., and Mineralogical Soc.; *J. Soc. Chem. Ind.*, **43**, 1130–1 (1924).—A general discussion on rock formation. P. NIGGLI in a paper "Homogeneous equilibria in magmatic melts" gave a diagrammatic representation of the formation of rock based on consideration of the homogeneous equilibria in the magma, and connected together a large number of natural phenomena as basis to discuss the laws pertaining to igneous rock. A. F. HALLIMOND'S paper "Eutectic and similar structures in silicate melts" dealt with the classification of silicate melts, the interpretation of structures, and suggested a method of investigation by examining polished surfaces under vertical illumination. C. H. DESCH in "The theory of crystallization in rock magmas" said that the best method of study was the detn. of the equilibrium diagrams of binary and ternary systems, combined with a detailed examn. of the effects of cooling for which purpose a knowledge of viscosities of magmas and their variation with temp. and composition is required. J. W. GREGORY in "Magmatic Ores" dealt with gold-quartz veins, chromite, the magmatic iron ores, nickel ores in norite, and the intrusive pyritic massives. J. W. EVANS' paper "Proposed researches on the chemistry and physics of igneous magmas and rocks" dealt with research under uniform or hydraulic press., and the effects of directed press., or shearing stress. W. A. RICHARDSON stated in "Some ultimate problems in petrogenesis" that the science of petrogenesis arose in the recognition of affinities shown by rocks associated in the field, and in such facts as the existence of petrographic provinces and disschistic dykes. He indicated as the chief needs of research: (1) Tabulation of the areas and exposed volumes of visible igneous rocks, so that further estimates of relative volumes could be made; (2) Systematic sampling of rock masses; (3) Investigation on behavior of silicate systems in presence of vapor phases; (4) Temperature gradients and their geographical distribution; (5) The thermal state of the earth, especially the upper crust. W. E. S. TURNER in "Some physical properties of silicate glasses and their possible bearing on the history of igneous rocks" discussed the weathering, corrosion, density, thermal expansion, and compressibility of glasses. G. W. TYRRELL'S "Review of recent work on the origin and differentiation of igneous rocks" said that the application of phys.-chem. principles to petrology was hampered by the scarcity of exact experimental high-temp. data. His paper also deals with crystallization-differentiation, influence of water and other volatile constituents in magmatic differentiation, and the origins of anorthosite, alkaline rocks, alnoites, and ultrabasic lamprophyres. Several of the speakers paid tribute to the Geophys. Lab. at Washington. H. H. S.

Silicic acids. R. SCHWARZ AND E. MENNER. *Berichte*, **57**, 1477–81(1924); *J. Soc. Chem. Ind.*, **43**, B908(1924).—The desiccation curve at 20°C of granular meta-

silicic acid, prepd. by the action of 80% H_2SO_4 on cryst. sodium metasilicate at 10°, shows definite breaks at $H_4Si_3O_8$ and $H_2Si_2O_5$. TSCHERMAK had previously named these acids granatic and dutholithic acids. The latter cannot exist at 32°C. If the dehydration is entirely intramolecular, the mol. of metasilicic acid must be at least hexameric. H. H. S.

New aluminum-silicon alloys. J. D. EDWARDS AND R. S. ARCHER. *Chem. Met. Eng.*, **31,** 504–8(1924). H. H. S.

Chemistry and Physics

Utilization of potassium rock. A. MESSERSCHMITT. *Giorn. di Chim. ed Appl.*, **6,** 431(1924).—The volcanic rocks are treated under press. of steam at high temp. in an autoclave and the phosphates are placed in a sol. form. Leucite, fonolite and zeolite were used to obtain the phosphate. The resulting rock was treated at a lower temp. with $NaNO_3$ and a $Na_2OAl_2O_3SiO_2H_2O$ was produced and KNO_3. The $Na_2OAl_2O_3$-SiO_2H_2O was possible for use in prepg. Al and soda alum. The methods of attack depend upon the nature of the rock, *i. e.*, if it is acid, basic or neutral. S. S. C.

Relations of thermal quality to value of fuel gases. C. F. CARRIER. *Chem. Met. Eng.*, **31,** 656–7(1924).—A theoretical discussion of the burning of gaseous fuels. The author concludes that within the limits of all commercial gases, so far as simple htg. effect is concerned, the B.t.u. standard is an equitable basis for detg. gas value. The gas which can be produced at the lowest cost per B.t.u. will be the most economical gas to use for htg. purposes. M. E. M.

Relationship between magnetism and thermoelements. J. C. THOMPSON. *Chem. News*, **129,** 156(1924).—A formula for the calcn. of electromotive power of a junction depending on magnetic susceptibility and reciprocal of atmos. vol. obtained, where H = electromotive power of a metal at 18°C measured against a subs. having e.m.p. 1.5 microvolts per degree less than Pb, A = atmos. vol. and H = magnetic susceptibility.

$$P = \frac{H + 7.52\,A}{5.52\,A} \text{ when } \frac{H}{A} \text{ is greater than } -2;$$

$$P = \frac{H + 1.63\,A}{0.37\,A} \text{ when } \frac{H}{A} \text{ is less than } -2.$$

The exptl. and calcd. results on a number of metals were tabulated and values obtained were concordant. S. S. C.

System of LiF and MgF_2. G. TACCHI. *Gazz. Chim. Ital.*, **54,** 777(1924).—The binary system of LiF and MgF_2 was studied and the eutectic curve produced. The point was found to be at 63.65% MgF_2, 36.35% LiF by wt., and at 669°C. The LiF used was dehydrated. S. S. C.

BOOKS

Introduction to Theoretical Physics. A. HAAS. Translated from 3rd and 4th editions by T. Verschoyle. London: Constable & Co., 1924. Price, 21s.

Kingzett's Chemical Encyclopedia. Third edition. London: Baillière, Tindall and Cox, 1924. Price, 30s.

Dictionary of Chemical Terms. London: E. Benn, Ltd., 1924. Price, 16s.

The Rare Earths. S. I. LEVY. Second edition. London: E. Arnold & Co., 1924. Price, 18s.

A Comprehensive Treatise on Inorganic and Theoretical Chemistry. J. W. MELLOR. Vol. V. B, Al, Ga, In, Tl, Sc, Ce and Rare Earth Metals, C. (Part I). Pp. x + 1004. London: Longmans, Green & Co., 1924. Price, £3, 3s.

Volumetric analysis. F. SUTTON. Eleventh edition, revised by W. L. Sutton and A. E. Johnson. London: J. & A. Churchill, 1924. Price, 35s.

Publishers of Chemical Books. *J. Soc. Chem. Ind.*, **43,** 1177–82(1924).—An acct. of the more important publishers of chem. books in the English language, beginning with the Oxford University Press founded in 1468. H. H. S.

PATENTS

Powdered sodium silicate and process of preparing the same. WALTER H. DICKERSON. U. S. 1,517,891, Dec. 2, 1924. Sodium silicate in the form of a dry powder composed of globular particles having a hardened glazed surface.

Producing aluminum fluoride-alkali-metal fluoride double compounds practically free from iron. HEINRICH SPECKETER. U. S. 1,517,686, Dec. 2, 1924. Process for producing aluminum-alkali-metal double fluorides practically free from iron, consisting in precipitating under stirring the said double fluorides from aluminum salt solns., containing iron by the addn. in presence of free mineral acid, of substances which on dissolving in water form fluorine ions and alkali-metal ions, the said precipitants being added to such an extent that just a little bit of unchanged aluminum salt is left in soln.

Alumina. New British Pat. No. 5699, 1923. (*Oil and Col. Trade Jour.*, **66,** 1432(1924).)—Alumina, alkali and alkaline earth silicates; double silicates; alkali metal compds., obtaining from complex silicates. Aluminium hydroxide is obtained by heating aluminium silicates such as china clay with alkalis or alkaline earths or their carbonates in presence of water in a closed vessel at 3–4 atmospheres press. or in absence of water to a like temp. Alternatively the silicate is heated with alkalis or alkaline earths or their carbonates in presence of water to a boiling temp. without press. so as to obtain a double silicate, and then this is heated with more alkali or alkaline earth or a carbonate thereof in a closed vessel as described above to obtain alumina and an alkali or alkaline earth silicate. O. P. R. O.

General

Comparison of American and foreign clays as paper fillers. MERLE B. SHAW AND GEORGE W. BICKING. Bur. of Stand., *Tech. Paper* No. **262.**—There are approx. from 200,000 to 300,000 T. of clay used annually in the paper industry of the U. S. The larger portion of this is of foreign source. The investg. reported was on relative merits of American and foreign clays. The essential requirements of a paper-making clay are: good color, low content of grit, mica, and other impurities, and uniformity. The paper section of the Bur. of Stand. is equipped for making paper in a semi-commercial way and under practical mill conditions. The exptl. paper-making equipment available for the work on clays consists of a 50-lb. wood tub beater with manganese-bronze bars and plate, a small Jordan with iron bars, a 4-plate screen, and a 29-in. Fourdrinier machine with wire 33 ft. long and having two presses, nine 15-in. driers, a small machine stack of 7 rolls, and a reel. Commercial soda and sulphite pulps, and 8 representative clays, 5 Amer. and 3 foreign, were used in this investg. The comparative study included tests for the amt. of clay retained in the paper, the quality of the paper produced, and those phys. properties of the clay (grit, etc.) that might affect the paper-mfg. processes. Measurements for clay retention included anal. of samples taken at 13 diff. positions on the paper mach. The retention values obtained for the 8 clays (Nos. 1 to 5, domestic; Nos. 6 to 8, foreign) were: using 20% clay, 0.620, 0.611, 0.636, 0.630, 0.633, 0.655, 0.642 and 0.655, resp.; using 30 per cent (runs varying, per cent being made for only 2 clays), clay No. 3, 0.600, clay No. 6, 0.632; using 10%, clay No. 3, 0.720, clay No. 6, 0.748; and using 5%, clay No. 3, 0.744, clay No. 6, 0.740. Similar tests were also made on samples from a commercial mill. The retention data agree with the results obtained in duplicate work in the exptl. mill of the Bureau. The commercial mill test also included a study of white-water losses. Detns. made during the $7^1/_4$-hr. test period show that, on a 24-hr. basis, without a save-all there would have

been a loss of 3,310 lbs. of clay and 2,369 lbs. of pulp. By using the save-all there would be a loss of only 168 lbs. of clay and 31 lbs. of pulp during that interval. The save-all not only increased stock recovery, by permitting the re-use of water with high concn. of stock for dilution purposes, but also effected a saving of thousands of gals. of water during the 24 hrs. Measurements made on phys. properties of the clays failed to show any correlation between such properties and the amt. of retention in paper, but the color and grit tests slightly favored the foreign clays, although not sufficiently to justify the consideration of only these properties in the selection of clays. Phys. tests made on the finished paper (bursting strength, finish, etc.) showed the results to be independent of the kind of clay added. The complete paper may be purchased from the Supt. of Documents, Govt. Printing Office, Washington, D. C. Price 15c.
H. F. S.

Rules for quarries. ANON. *Quarry and Surveyors' and Contractors' Jour.*, **29,** 314–7(1924).—The Mines Dept. of Gr. Br. working in conjunction with the principal representative bodies of the industry has issued a new code of rules, published as Mines and Quarries—Form 88. The text is given, covering such features of the industry as safety of quarry, use of explosives, means of access, mach. and plant, first aid arrangements, duties of owners and officials and duties of employed. O. P. R. O.

Requesting a fineness guarantee for lime marls. RUDOLPH BLUNCK. *Tonind. Ztg.*, **48,** 1117(1924). H. G. S.

Smoke abatement conference. Nov. 4–6, 1924, Manchester, Eng. *Jour. Soc. Chem. Ind.*, **43,** 1088(1924).—Twenty-two papers included: smoke legislation in England and America, diagrams on measg. atmospheric pollution, effect of atmospheric impurities on bldgs., the work of the Departmental Comm. on smoke abatement, and several on boiler design, electricity, and the use of power other than that of coal.
H. H. S.

Fuel Congress at Paris, Oct. 2-3, 1924. *J. Soc. Chem. Ind.*, **43,** 1087(1924).—Rozak showed how Berthelot's method of hydrogenation had made possible the synthesis of hydrocarbons. Kling discussed the production of synthetic paraffin by the Bergius process. Mailhe dealt with the manufacture of motor fuels from vegetable and animal oils. By using magnesium chloride as catalyst, he obtd. 68% of synthetic fuel from the fatty acids of linseed oil. Industrial manuf. presents no difficulty but is only financially feasible with very cheap vegetable oils. Synthetic fuel has also been obtd. from beeswax and chlorophyll, this last suggesting that in time a new branch of the cellulose industry will be established. Goutal, describing the Andry-Bourgeois and Olivier process, stated that starting from water-gas derived from lignite coke, these authors obtd. a synthetic fuel which after hydrogenation gives petrol of d. 0.76 and heat value 11,539 calories per kg. Lumet spoke on the use of vegetable oils as motor fuel; du Boistesselin on the better management of forests for the production of wood charcoal; Auclair on the use of charcoal-gas generators on lorries; Gramme on colloidal fuel; and Guiselin on the catalytic manuf. of synthetic fuels. H. H. S.

Crushing and grinding. S. G. URE. *J. Soc. Chem. Ind.*, **43,** 1144–52(1924).—The two laws connecting the energy required and the sizes of the mat. before and after subdivision are Rittinger's law and Kick's law. The former assumes that the new surface produced during the process of crushing or grinding is a meas. of the energy consumed in the process. Practical results show that the amount of work done compared with the area of fractured surface is constant for coarse sizes, but the amount of new surface produced in fine grinding is greater than the energy required by the above law. This is attributed to the possibility of incipient fractures during the coarse crushing stage. Rittinger's law is expressed mathematically: $H = C\left(\frac{1}{d_2} - \frac{1}{d_1}\right)$ where

H is power required, C a constant dependent on the mat., and d_1 and d_2 the initial and final diams. or lineal dimensions of the mat. Kick's law states that equal amts. of energy are required for the reduction of equal quants. of mat. through the same reduction range. It is based on the assumption that direct press. of const. amt. per unit is applied to subdivide each particle which breaks up into smaller particles of similar shape. This is written: $H = C \log \frac{d_1}{d_2}$. Neither law is quite accurate, but a satisfactory expression may lie between the two. The various types of machinery are then dealt with, numerous illustrations being given, under the headings: jaw crushers, disc crushers, and gyratory crushers. H. H. S.

Sir Archibald Geikie, O.M., doyen of British geologists, and a past-president of the Royal Society of London, died at his residence at Haslemere, Eng., on Nov. 10. Born in Edinburgh on Dec. 28, 1835, he was educated at the High School and University of that city, and at the early age of 20 he was appointed to the Geological Survey, to which he was attached until his retirement 46 years later. In 1881 he became Director-General of the Geological Survey of the United Kingdom and Director of the Museum of Practical Geology. In 1871 he was appointed to the newly-founded Murchison Professorship of Geology and Mineralogy in the University of Edinburgh. From the first Geikie was a field geologist, and one of the features of his professorship was the weekly excursion not only around Edinburgh, but often to distant parts of the Highlands. Geikie's sympathies were all with the newer school of geologists who maintained the supreme importance of the ordinary forces of nature in molding the earth's surface, as contrasted with the cataclysmic theories of the older school. He was one of the first geologists to recognize the importance of microscopic investigation as an adjunct to field work. He found time to travel over most of Europe and visited America first in 1878, rambling over hundreds of miles in Canada and Western America. This visit intensified his interest in volcanoes and enabled him to discover and interpret similar evidences of volcanic outbursts in Britain, the results being published in his "Ancient Volcanoes of Great Britain," and "Geological Sketches at Home and Abroad." In 1882 he published the "Textbook of Geology," which is authoritative on this subject. Geikie had a human side to his character. He was a leading spirit of the Royal Society Club, a dining association older than the Royal Society itself, and one of his books is the "Annals of the Royal Society Club." As Romanes lecturer in 1898 he took for his subject "Types of Scenery and Their Influence on Literature." As president of the Classical Assn. he published "The Love of Nature among the Romans," and another work is "Landscape in History." Geikie was knighted in 1891 and received the crowning honor of the Order of Merit in 1914. (*The Times*, London, Nov. 12, 1924.) H. H. S.

BOOKS

Technical Organization: Its Development and Administration. J. M. WEISS AND C. R. DOWNS. New York: McGraw-Hill, Inc., 1924.

Report on heat insulators. E. GRIFFITHS. *J. Soc. Chem. Ind.*, **43,** B983(1924).—Refers to cold-storage. Thermal conductivity values between —15° and 115°C were obtd. for cork, slag wool, charcoal, diatomaceous earth, rubber packings, pitch pine, facing cement, bitumen, concrete blocks, etc. The sp. ht. of five of the materials was detd. by a special calorimeter. H. H. S.

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BULLETIN

of the

American Ceramic Society

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific and Art Questions and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

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THE THIRTIETH ANNIVERSARY OF CERAMIC EDUCATION

The beginnings of ceramic education were made thirty years ago. These took energetic organizing, securing of influential backing and a demonstration of the prospective industrial value. It was in Ohio that this beginning was made, but as the effectiveness of collegiate training became recognized other state colleges organized ceramic departments until now there are ten in the United States and one in Canada specializing in ceramic science and engineering. There are, too, several schools devoted especially to ceramic art. It is fitting that there be a national celebration of the anniversary of the beginning of this organized training with due recognition to those practical men and scientists who by their individual efforts made possible this collegiate training.

It is fitting also that the American Ceramic Society should lend its support to such a celebration. And since Ohio State University is the place where this start was made, it is not only fitting but gracious that that University has extended invitations to ceramists, industrial, educational and research, to meet on its Campus during the week of February 16, to consider the values realized and the means of greater values which are possible.

Following are addresses made at the first meeting of the Ohio Ceramic Industries Association held January 16 and 17. These are so germane to this anniversary of the beginning of ceramic education, the celebration

of which the Ohio Association is sponsoring, that they are worthy to be included as a part of this anniversary number.

WHAT THE INDUSTRIES WANT FROM THE CERAMIC SCIENTIST

By Robert D. Landrum

My father once said to me, "Whenever your job is such that your are not learning something new each day, quit that job." Any ceramic industry that is not so organized that it is continually learning something new about the process which it uses, or the product which it is making, will sooner or later be forced to quit. The ceramic scientist should be the factor in such an organization, responsible for this continual accumulation of specific knowledge, the intelligence department, as it were, the catalyzer of progress.

Now just what do we mean by a ceramic scientist? And just how does he differ from the ceramic engineer? The term is rather new, and I expect that each of us here has a different conception of its meaning. In my mind, the distinction between the two is similar and almost parallel to that between the chemist, or better, the industrial chemist and chemical engineer.

It is difficult to distinguish sharply just where the attributes that make one man a ceramic scientist end, and those that make a ceramic engineer begin. In fact, I am somewhat of the opinion that the training of the ceramic engineer should be such that, first of all, he would be an embryonic ceramic scientist. The work of the two, the point-of-view, and generally speaking, the personal equation of the two, after they have been matured by experience in an undergraduate school, and by those rich years immediately following during which they have struggled to round off the corners and seek for their proper niche—are quite different.

The ceramic scientist will probably never be satisfied. One truth found, and he's on the trail of another. Do not think for a moment that this seeking will not have in the background a desire to find a useful truth, but, unlike the engineer, the thought of usefulness, or certainly the thought of immediate usefulness, will be in the background. The engineer in his proper niche will, in time, acquire the ability to take these truths that are found by the ceramic scientist, and apply them to the cheapening of process and the improvement of product.

I was tempted when given this subject of "What Do the Industries Want from the Ceramic Scientist" to play upon words and say that, as yet, the average executive in our industry does not consciously want anything from him. This same executive, long ago, reached the point where he realized his need of the lawyer, his need of the investigator of markets,

and the expert accountant, and will not today consider the cost of these, for he knows by experience that they are utterly necessary to his financial success and peace of mind.

Some time ago, it was to the point to say, "There's many a pottery without pyrometers, but none without adding machines." But, today, the absence of one is about as unusual as the other. The ceramic engineer has seen to this, and, today, he is thoroughly "sold" to our industries, and our schools are having a difficult time turning out ceramic engineers fast enough. In fact, the demand has been so strong that many men who should be doing the work that is waiting for the ceramic scientist, are working with production problems, or, perhaps, if more fortunately guided, are using their deductive ability in development work, regarding application of fuels, heat transfer, methods of mixing, milling, mechanical separation, filtration, hydraulic pressing, leaching, drying, etc.

The ceramic scientist has a creative mind, and if you do find him buried in routine work, you will find him impatient and dissatisfied, and probably satisfying neither himself nor those who employ him.

Even the work of the ceramic scientist can be divided into two classes: (1) The abstract search for fundamental truths, which is so slow and costly that the work will probably be carried on by endowed or government laboratories, and (2) the sound technical scientific work which must be carried out by or in coöperation with the industries themselves.

In further discussion of the subject, I will continue to refer to the ceramic scientist as the technical scientific worker, rather than the absolute scientific worker. Workers of the type of Mellor in England and Rieke and Simonis in Germany, are the sort that I like to consider as ideal ceramic scientists. And, of course, there are several in this country, too, but, for fear of missing some, I will not mention any.

This type of work, you can readily conceive, cannot be done by men whose whole time of preparation has been four college years. I do not mean to say that men with only four years actually in college, cannot be developed through their work after college, into scientists of this sort. We must remember that the thinker will see to it that his regular work is, as it were, postgraduate.

Most ceramic scientists, you will readily agree, are today found in the universities, the government bureaus, and in endowed laboratories. But the migration has started. In the chemical industries, this migration started much sooner than it has in our industry. And it has robbed the universities of their best instructors, and the bureaus of their key men. And the rewards of this have been such that today the schools are forced to examine with microscopic care, the attributes of the undergraduate, so that not a single boy with true scientific spirit and with creative ability will be missed.

These students are today carefully groomed for sound scientific work, and upon graduation, they are fairly fought for by the industries.

Get ready, Professors Watts, Parmelee, Brown, and you other heads of various ceramic departments of our schools. Our industries are next—for there certainly is a place for these ceramic scientists within the industries themselves. By this, I do not mean that each small plant must have its separate laboratory. But each must have a ceramic scientist that it can call its own.

Many of these men probably will work as fellows in the universities and technical institutes, some of them by special permission, in the government laboratories, many of them, we hope, in the laboratories of the separate industries themselves; the work of all perhaps linked and coordinated through some system of organization that will prevent duplication on problems of general interest; an organization that will guide each toward a definite end even on special problems.

Now I come to the real subject of my paper. And I am afraid you are going to be disappointed, not that my paper is going to be much longer, but because I am unable to show very much more need for the ceramic scientist in the industries newly called ceramic, than there is need for him in the strictly speaking clay working industries.

The very truths that we want the ceramic scientist to seek in the newly called ceramic industries are, for the most part, those that must be sought for in the clay working industries. Of course, the specific problems are different, but the general problems are one and the same.

While in the enameling industry we want the ceramic scientist's education to be such that he will know something of the fundamentals of metallurgy, nevertheless, his preparation must be such that he will have made a general survey of our ceramic information, that he can, and will have, as his chief goal, the determining of the physical constants which we need, and the creation of new conceptions of our materials and products.

The ceramic scientist must develop a system of the chemistry of the silicates, as complete and illuminating as the wonderful system of organic chemistry. Shall we call this system "ceramics," in the larger sense, and in keeping with our new definition of "ceramics?"

On first thought, it may seem peculiar that in industries as fundamental as ours, industries whose products are older than historical men, sound technical science has had so small a part, especially when we realize the remarkable perfection in craftsmanship which many products showed generations and generations ago. When we consider the matter carefully, however, it is not strange, for although our products seem simple, since they are made from familiar things (rocks, clays and minerals) and by seemingly simple processes, they are not. These same familiar raw ma-

terials are so complex that they almost defy analysis as to their chemical constitution.

This task which we are assigning to the ceramic scientist is an extremely difficult one. Yet, until we do develop this system of ceramics, which is neither chemistry nor physics nor mineralogy but includes all three as applied to silicates—we can only progress slowly and in a piece-meal fashion.

Searle, in the preface to his huge volume on the "Chemistry and Physics of Clays" just published, says, "Physicists have chiefly concerned themselves with matters in mass; chemists have dealt chiefly with the atoms and molecules of simpler and, therefore, more easily understood substances." He goes on to say that most manufacturers and users (of ceramic products) do not yet realize the enormous importance to them of chemists and physicists with highly specialized knowledge regarding this industry of ours.

I will go one step further and say that probably the physicist as such, and the chemist as such, will never work closely enough together to get the results we desire as quickly or as completely as the scientist I have tried to describe, who will be both, not a physical chemist,[1] but the ceramic scientist, who will overcome the difficulties, enumerated by Searle, due to the fact that it is difficult to obtain our materials in a pure form, that most of them are insoluble at the start, apparently inert at ordinary temperatures, and difficult to obtain in an easily recognizable form (such as crystals of convenient size).

This ceramic scientist, too, will be equipped to investigate the fundamental principles that Searle lists, which list many here can lengthen: effects of texture, causes and control of strength, distribution of water in partially dried articles, strains produced in drying and firing, causes and prevention of distortion, study of chemical equilibrium (almost impossible), size of particles and influence of this on chemical reactions and physical changes, the study of these at high temperatures, colloidal phenomena, plasticity.

I have already mentioned the physical constants (these I need not enumerate) and the determination of the true chemical constitution of our materials and products. Both the ceramic engineer and the ceramic scientist should be so well grounded in fundamental subjects that four years is all too short for the job. Both should, in my opinion, be given courses so that their undergraduate degree would simply be bachelor of science, with special proficiency in ceramics. Electives could well be offered after the freshman year, according to the bent of the student towards engineering of pure ceramics.

Let them become ceramic engineers or ceramic scientists after their postgraduate work either in the universities or in the laboratories, public

[1] *His* attributes are well defined and understood and his training would never give him the specialized knowledge which we require.

or semi-public, or in the industries themselves, of course, upon the submission of theses and professional records.

Then, too, for those who can afford three years of resident graduate work, a doctor of ceramics degree. It might be well to provide, also, for a complimentary degree, doctor of ceramic science, for those who have done unusual non-resident work.

As Professor Johnson said some four years ago, "The fundamental research which industry needs costs a lot of money, experience never being a cheap article, but the lack of it will be much more expensive to all of us. It is an insurance, an insurance against ignorance, and for the benefits obtained, the annual premium is very small, provided the work is put into the hands of properly qualified men."

This is what the ceramic industries want from the ceramic scientist: insurance against ignorance, a factor in their organization responsible for the continual accumulation of specific knowledge.

IDEAL COÖPERATION BETWEEN THE UNIVERSITIES AND THE INDUSTRIES

By A. P. Taylor[1]

Ideal coöperation between educational institutions and the industries would make itself felt within a few years in our whole economic structure. Advancements in manufacturing methods, developments in products, new inventions, and lowering of costs, will come rapidly by the application of scientific knowledge and control. Active coöperation between the ceramic industries and the universities is needed in order to make the best use of the information which is now available, to encourage original researches, and to determine the course of study which will produce men fitted in the best manner to serve the industry.

The function of the university is to add to our store of knowledge and to disseminate it through its own organization and the trained men which it produces. Its function would accordingly be promoted by an enlargement of its research activities, and were these directed toward the solution of problems of vital interest to the industry, a mutual benefit would result, which is the aim of any coöperative effort. In such work the industries must lend their united support, not only in a financial way but also in giving the attention to the work which it deserves, and in devising means for putting into practical application, the new ideas and new methods which result.

Coöperation with the industrial field through the establishment of research agencies is properly a work of the universities. They afford facili-

[1] Mgr., Charles Taylor Sons Co.

ties for obtaining expert advice in all branches of science, and insure unbiased efforts. There are already a number of schools maintaining organizations for industrial research, and the number is increasing yearly. Among these may be mentioned the Massachusetts Institute of Technology and the University of Pittsburgh. The Mellon Institute under the direction of the latter school has had singular success in industrial research. The fellowship maintained here by the Refractories Manufacturers Association has been in operation for eight years, and from a modest beginning has grown to be the most important of this Association's activities, and it is today indispensable to the refractories industry.

While ideal coöperation has been pictured here in the form of a research organization established by the university, fostered by the industry, and working toward the advancement of our knowledge of ceramics, it is probable that even closer contact between the university and the industry would be beneficial.

In many other lines we find consultants of recognized ability obtainable for the solution of engineering and technical problems. In the ceramic field it is difficult to obtain such assistance except on problems of rather general nature, and until this condition is changed, a decidedly beneficial service would be rendered by making expert consultants available.

The first suggestion for industrial research in this country was made by Felix Pascalis before the Chemical Society of Philadelphia in 1801. It is interesting to note that he urged research in ceramics "in the production of good earthenwares." Our lack of knowledge now is evidently not due to a lack of appreciation for the need of research in other years, but to our lateness in getting started.

Our fund of technical information on ceramics in this country has come within a few years. The beginning of our education along that line may be traced back to the institution of a ceramics department at the Ohio State University by Professor Orton. The growth of this branch of learning has been rapid, and will continue so long as the industries are able to be benefited by the information which is carried out to them.

The strides that have been made, and the benefits that have accrued to the industries, are the results of original investigations and research. This must be true, else our knowledge of ceramics would not have advanced, and a cursory comparison will prove the increase in our fund of information.

We have reached a highly competitive stage in all lines of industry, and unless a manufacturer makes a better product tomorrow than he is making today, he will soon be pushed aside.

Results in the past insure the success of a research project, and present conditions demonstrate the need. Our universities have an opportunity to be of invaluable assistance, by pointing the way toward greater econ-

omies and better products. By a united effort in this direction, we shall show the spirit of ideal coöperation.

THE DEVELOPMENT OF A CERAMIC COURSE TO MEET THE DEMANDS OF THE INDUSTRY

By Arthur S. Watts

The Ohio State University *Bulletin of the College of Engineering* of which the Department of Ceramics is a part states:

> The purpose of the College of Engineering is to instruct students in the fundamental sciences and arts, upon which all engineering rests and to impart such special and technical knowledge of the various branches of engineering as will enable its graduates to maintain themselves while gaining their professional experience.

This statement establishes two facts: (1) the ceramic course as provided at present is intended to produce ceramic engineers. (2) The university does not pretend to produce a finished product, but only to furnish fundamental knowledge.

The university does acknowledge that the training provided shall be such as will enable the graduate to earn his wages during his period of training in the industry, and not be a burden to his employer during that period. To the industrial or engineering world, the sciences of chemistry, physics and mathematics are recognized as fundamental and essential, and in view of the limited training in rhetoric and grammar which our public schools provide, it appears necessary that these be given some place in any college training. Beyond these, what fundamental knowledge would the ceramic industry be justified in demanding of a ceramic graduate, whether he be an engineer, an artist or a scientist?

In the consideration of raw materials, he should have the fundamentals of geology and mineralogy. In plant control and operation, he should have the fundamentals of mechanics, power generation, and power transmission. If he is to be useful in plant layout or development, a knowledge of drafting is necessary. To any educated man serving the ceramic industry, a knowledge of fuels and their combination is essential. All ceramic schools have found that these subjects are necessary regardless of the field of service into which their graduates go.

The university, therefore, has no choice but to insist that these subjects be properly provided for in its curriculum.

As a general assumption, we may say that all of the student's time, not required for the mastery of these fundamentals, should be devoted to such study as will equip him to serve the industry. The introduction of non-essential courses must be at the expense of the time otherwise devoted to ceramic instruction because educators have proved that to overload a student results in inferior training in all his work.

Most schools hold, however, that some non-essential courses are advisable because otherwise the student becomes lop-sided and cannot make proper contact with those outside his own field, and this opinion is strongly supported by all the large business organizations into which ceramic graduates go. Most schools demand a knowledge of surveying, and a majority demand training in foreign languages. In a majority of schools some time is allotted to the student's choice of subjects other than those prescribed.

In the five original ceramic schools, the essentials consume from 51% to 75% of the student's time, as indicated in Table I.

TABLE I

CERAMIC CURRICULA

Fundamentals	Ohio State %	Illinois %	Iowa State %	Rutgers %	Alfred %
Mathematics	14.0	13.3	15.0	11.5	13.5
Chemistry	13.0	16.2	14.0	17.0	15.5
Physics	8.0	8.0	9.0	4.0	8.5
English	4.0	4.4	6.0	6.0	1.5
Geology and Mineralogy	4.0	..	12.0	5.5	3.5
Mechanics—M.E. and E.E.	9.0	8.3	13.0	5.0	5.0
Engineering Drawing	7.0	6.0	6.0	3.0	3.5
Fuels	2.0	1.4	..	2.0	..
	61.0	57.6	75.0	54.0	51.0
Ceramics					
Ceramic Fundamentals	22.0	18.5	16.0	16.0	15.5
Ceramic Research	11.0	8.5	4.0	8.5	15.5
	94.0	84.6	95.0	78.5	82.0
Cultural and Electives					
Surveying	2.0	1.4	3.0	..	3.5
Foreign Language	..	6.0	..	10.0	8.5
Electives	4.0	8.0	..	8.5	4.5
Miscellaneous	..	..	2.0	3.0	1.5
	100.0	100.0	100.0	100.0	100.0

The allotment of the remaining time to ceramic fundamentals and research is also indicated in the same table. This brings us to the consideration of the subject before us. How can we best utilize this available time to meet the needs of the industry? The allotment of time to ceramic courses at Ohio State University is indicated in Table II.

No place is provided in the University schedule for manual training courses in ceramics or for a study of plant design and operation but these are provided for by the Ceramic Industrial Experience Courses and by the Plant Inspection Trips. The Industrial Experience Courses each require 10 weeks' plant experience in an approved plant, a written report of the work done and a statement from the employer that the services were satisfactory.

TABLE II

ALLOTMENT OF TIME TO VARIOUS CERAMIC COURSES AT OHIO STATE UNIVERSITY

Course No.		%
401	Origin, Occurrence and Phys. Properties of Clays, etc....	1.8
405	Mining, Preparation and Forming.....	2.2
601	Drying and Burning.....	2.2
605	Bodies, Glazes and Colors.....	1.8
610	Refractories and Test Furnaces.....	2.2
615	Ceramic Calculations.....	2.2
620	Testing of Clays, etc.....	2.2
701 and 702	Research in Bodies and Glazes.....	4.4
703	Research in Colors.....	2.2
704	Research in Metal Enamels.....	2.2
705	Design—Plant Layouts.....	2.2
706	Design—Driers.....	2.2
707	Design—Kilns.....	2.2
710 and 711	Thesis—Research.....	3.0
		33.0

REQUIRED COURSES OUTSIDE CURRICULUM

430	Sophomore Summer Industrial Experience.
431	Junior Summer Industrial Experience.
630	Junior Factory Inspection Trip.
631	Senior Factory Inspection Trip.

The Plant Inspection Trips each require one week spent in visiting ceramic plants under the direction of an instructor and an examination covering the plant arrangement and processes observed. This course has been designed to produce ceramic engineers because the call has been for men with a broad ceramic training rather than for specialists.

The development of new curricula to produce ceramic artists and ceramic scientists or the modification of the present course to meet these needs and the alteration of our present curriculum to produce a better ceramic engineer are subjects that demand very serious consideration.

PRESIDENTIAL ADDRESS—1922[1]

BY FRANK H. RIDDLE

EDITOR'S NOTE: The presidential addresses by Mr. Riddle and Prof. Greaves-Walker would have appeared earlier had a YEAR BOOK been published. It has been found of more service to publish the YEAR BOOK items from time to time, hence a "YEAR BOOK" known as such will not be issued this year.

These two addresses are particularly pertinent now when we are this month celebrating the thirtieth anniversary of the beginning of ceramic education. Both of these addresses are germane to the purpose of this occasion.

[1] Presented at the Pittsburgh Meeting of the AMERICAN CERAMIC SOCIETY, February 12, 1923.

Introduction

The end of the year 1922 marks the close of an important year in the history of the affairs of the AMERICAN CERAMIC SOCIETY. First because it is the closing of the first quarter century of the life of the SOCIETY and second because it is the closing of the first full year of operation with a full time secretary in active charge of the execution of the affairs of the SOCIETY.

The First Quarter Century

It is fitting that brief mention should be made of some of the more important developments which have been accomplished during the life of the SOCIETY. Perhaps the most important result of the activities of the SOCIETY is the recognition of the ceramic engineer by engineers in other fields of endeavor. This is particularly true among the electrical, chemical and construction engineers. The second important point is the more general knowledge, by the public, of the broader meaning of the word ceramics. This recognition and general knowledge has, of course, been brought about largely through the wide distribution of the publications of the SOCIETY and other technical journals. These publications, however, have only been the media by means of which ceramic knowledge has been distributed and nothing could have been accomplished if it had not been for the untiring efforts on the part of many of the members of the SOCIETY in undertaking extensive researches and then being willing to impart their knowledge to others.

The ceramic researches which have had the widest industrial application and which have resulted in the saving of millions of dollars are those of Edward Orton, Jr., particularly his work on the "Rôle Played by Iron in the Burning of Clays." The facts brought forth in these researches are now such common knowledge that we are too apt to forget that the information was gained in the earlier days only after painstaking and exhaustive work had been done with the poor equipment available at that time and with little knowledge of fundamentals. We should be very proud of the fact that the man who has been so largely responsible for the founding of ceramic schools and the AMERICAN CERAMIC SOCIETY should also have been responsible for one of the greatest ceramic researches.

The development of refractories has also played an important part in the progress of a very wide range of activities. The improvements made in refractories are probably more keenly felt by the general public than improvements in any other ceramic product and the savings due to less interrupted production brought about by the improved refractories cannot be estimated. Improvements now in progress in refractories will unquestionably have a tremendous influence on further betterments where refractories are used to any extent.

The development and experimental stages in the construction and operation of continuous kilns have reached a point where it is safe to predict that periodic kilns are soon to be obsolete equipment and those who use them will be seriously handicapped in competition. It is interesting to know that the fuel saving is only one of several advantages of the continuous kiln over that of periodic kilns. The percentage of number one product and the uniformity of quality of this product have resulted in savings to the manufacturer as well as more satisfaction to the customer.

Every branch of the ceramic industry has shown marked improvement and it would be difficult to tabulate these improvements in the order of their importance. This question should not be passed, however, without making some reference to the improvement in architectural decoration which has been made possible through the coöperation of the architects and ceramic building material manufacturers.

The Year 1922

The year 1922 might be said to be an experimental year, the purpose of the experiment being to see if we had grown sufficiently to undertake larger and more expensive operations. This step was deliberately taken with the knowledge that it might be necessary to draw on the reserve unless we were particularly successful in the membership and advertising campaigns. Steps taken to assist in this work were the centralizing of all activities at Columbus with the exception of the advertising, the enlarging of the *Journal*, and the development of a more nearly complete abstract section and the publication of a *Bulletin*. The original plan was a semi-monthly *Bulletin* which would carry its own advertising and carry news which would be of particular interest to the plant operators and foremen and also provide a means of reaching out to interest prospects in memberships. This was abandoned after the first issue and issued monthly under the same cover as the *Journal*. It is not possible to predict whether the first method was better or not but it was felt by some that the advertising in the *Bulletin* would mean less advertising in the *Journal* and that the net result would be the same.

A summary of the year's work shows that our income was not great enough to take care of our expenses and that it has been necessary to withdraw some money from our reserve. The receipts from advertising, which source was counted on largely to meet our needs, were not as great as some of us felt they should be, considering the increase in circulation and changes in the character of the combined *Journal* and *Bulletin*. The accompanying table shows the relative financial growth in receipts and expenses during the years 1920, 1921, and 1922.

THREE YEAR COMPARISON OF INCOME AND EXPENSES

RECEIPTS

	1920	1921	1922
Dues	$9606.85	$11342.10	$15518.31
Advertising	5259.00	7864.55	12648.50
Other sources	2803.10	3087.35	3394.81
	17668.95	22295.00	31561.62

EXPENSE

	1920	1921	1922
Journal, Printing, Abstracts, Drawings, etc.	$8134.65	$10827.96	$15050.52
Advertising Commission	....	1345.08	2819.99
Other *Journal* Expense, Including Salaries	2558.47	3400.03	2754.83
Secretary's Office, Salaries	2199.96	4554.94	9197.08
Office Expense	781.17	2106.08	3060.40
Committees and Divisions	643.44	781.70	1947.51
Traveling	711.53	1023.00	1145.60
Meetings and Incidentals	622.66	2104.79	1908.55
	15651.88	26143.58	37884.48

NET INCREASE IN MEMBERSHIP

	1920	1921	1922
Personal	124	199	289
Corporation	15	46	79

The receipts for 1923 will unquestionably be greater than those for 1922 as we will have at least a normal growth in membership and fully expect an increase in advertising. This expectation is based on an investigation of the volume of advertising handled by some of the trade journals during the past year. We have been informed through reliable sources that most trade journals suffered a substantial loss on advertising during 1922 as compared with previous years. If this is so, we have no cause for complaint as our advertising receipts show a substantial gain in 1922. If we receive the same increase in 1923 that other journals are anticipating, we can also look forward to an increase particularly in view of the general good financial condition of the country.

During the past year, the advertising has been handled entirely from the Atlantic Coast. However, during the past month arrangements have been made to handle it through the Columbus office, arranging to have local solicitors throughout the country. How successful this system will be cannot, of course, be determined for some time to come. However, it places the advertising directly in our own hands and also gives us a wider field in which to solicit advertising. It is therefore reasonable to expect an increase in revenue.

The growth in membership has been very substantial, the gain over last

year being 20%. Best of all a foundation has been laid for further growth particularly in corporation memberships.

The exhibit of ceramic products at St. Louis was a success and the increase in interest in the present exhibit clearly shows the possibility of creating a new source of revenue to help meet our expenses. If we expect to keep abreast of the times, we must know what others are doing and an exhibit is justified for this if for no other reason. If revenue can be derived at the same time we should not neglect the opportunity as we can not only rent space but also increase the advertising in the *Journal*.

The Full Time Secretary

The results of the last year's work have shown that we were justified in employing a full time general Secretary-Editor, and I wish to express my appreciation to not only Mr. Purdy, but also to Miss Binns, the Assistant Secretary, and Miss Van Schoick, the Assistant Editor.

The team work which has been created in Mr. Purdy's office has been a great help to the SOCIETY and we are indeed fortunate in having a corps of enthusiastic hard workers so vitally interested in our affairs. Mr. Purdy has worked ceaselessly and I am sure that by the end of 1923, we will have the SOCIETY in a strong financial position.

The movement started last September to have all Divisions represented on the Board of Trustees is a good one and should be carried through as rapidly as possible. This will necessitate the first Trustees from the various Divisions being elected for different terms of office so as to start off properly with the overlapping term plan that has been used in the past.

As previously stated, the past year was, to a certain extent, an experimental year insofar as expenses were concerned. It is reasonable to expect that the income for 1923 will meet the expenses which will be about the same as those of 1922. [However, I wish to urge that the SOCIETY adopt the policy this year of living within our income and not drawing on our reserve.] The Secretary's office is so organized and his work so arranged this year that he will have considerable time for field work strengthening Local Sections and creating new ones. This being the case, we can expect our income this year will be all that our organization can reasonably expect at the present time. Bearing this in mind, we should consider our present average expense as the maximum for the present and live within this limit, maintaining our reserve as far as possible for emergencies.

Future Progress

In reviewing previous presidential addresses, the suggestions for future progress are so well covered that it is difficult to make any new suggestions. However, past presidents have brought out some very important points which should be emphasized.

New Divisions

The SOCIETY has never encouraged the discussion of mechanical equipment largely because it has to be done by the manufacturers and hence appears to be too much like advertising. Clay working machinery and equipment has been criticized as compared to that developed in other industries. If this criticism is justified, we would be warranted in attempting to create more interest in mechanical developments and should seriously consider how best to accomplish this. We all know that the greatest labor saving is accomplished by means of mechanical devices and it is important that our operating costs be lowered if we expect to compete, particularly if we export.

Standardization

This subject is extremely important but has been brought up so often that it need only be mentioned here. So little work need be done to complete and compile the work already accomplished that this should be done in the near future. We can capitalize on this work in our membership work as well as in adopting standard tests for our own use and comparison with other investigators' work.

Ceramic Hand Book

The compilation of a ceramic hand book should also be undertaken. Considerable data is already available and could be collected with comparative ease if the SOCIETY as a whole would undertake the work. The work of preparing a text book, as already undertaken by the Art Division, represents a great deal more work than the preparation of the hand book and yet undoubtedly will be accomplished with great success.

A hand book which could be used by engineers in general would bring us to the attention of the technical world in a way that nothing else would, and would not only strengthen our position but also be a real help in the engineering field.

Ceramic Education

Ceramic interests can best be served by developing three classes of trained ceramists. These men should be developed in two classes of schools. The first class should be developed in trade schools. These schools would naturally be placed in ceramic centers and their aim would be to interest and develop the young clay workers in semi-technical lines at the same time they served their apprenticeships. This would develop these men for positions as foremen and ceramic routine men and thus not only better their conditions but also give them a better understanding of and a willingness to coöperate with the executives and technical staffs.

The second and third classes should be made up of high grade men thoroughly trained in ceramic engineering courses of the highest standing.

The tendency in all engineering colleges at the present time is to turn out a great number of graduates and thus overcrowd the industries with indifferently trained men. This should be avoided in ceramic engineering courses particularly if the trade schools are developed to the point where they should be.

Technical training in the ceramic courses should be carried out with a view of training the capable students who are able to carry on with the work, and developing two classes of men. One, those who will be capable of carrying on high grade research work, and two, those who will eventually be capable of becoming plant executives. This would necessitate at least a five-year course. The students would develop sufficiently in the first three years so as to decide which of the two branches of ceramics to specialize in during the next two years.

As long as plant foremen are uninterested in any knowledge of ceramics and plant executives are developed from office employees, who have no technical understanding of ceramics, the ceramic engineer cannot expect to develop the industry as he should. If he leaves school with the purpose of accomplishing some improvement based upon sound engineering principles in which he has been thoroughly grounded, his efforts will be successful. The other class of trained men will also accomplish something, as they will leave school with the knowledge that the executive is in a better position to get results than anyone else in a manufacturing organization, and they will work toward the executive positions, applying their ceramic knowledge as they go and eventually becoming broad-minded, well balanced men, capable of handling affairs in the best possible way.

Conclusions

I wish again to emphasize the fact that the most valuable assets we have are our publications and that these should always be considered first and be given preference over all other interests. I feel that any progress made the last year has been largely due to the enlarging of the scope of the *Journal* and the decision to foster new publications such as the Refractories Bibliography, and the Art Division Text Book. Work of this character should be continued.

In closing, I wish to express my thanks and appreciation for the confidence placed in me by the members of the SOCIETY in honoring me with this office.

I want to thank the Board of Trustees for their enthusiastic willingness to be of service at all times. Also the members of all committees and Division and Section Officers. We cannot expect to accomplish anything without this coöperation on the part of all. Friendly criticism and suggestions should be given and taken at all times and if this is not done, we will not grow and broaden as we should. I wish particularly to thank the

Secretary and his force for the splendid coöperation they have shown and the hard work which they have done. Also my secretary, Miss Grace Wohlfelder, who has taken an active interest in carrying on the work. In retiring from office, I wish to express my desire and willingness to assist the SOCIETY in every way possible.

THE PRESIDENTIAL ADDRESS—1923[1]

BY A. F. GREAVES-WALKER

This year marks the twenty-ninth anniversary of the birth of ceramic education in this country, the first ceramic department being organized at Ohio State University by Edward Orton, Jr. in 1894. Ceramic schools organized along trade school lines had been known in Germany for some years previous to that date, but it remained for Dr. Orton to put ceramics in all of its various branches on an engineering basis. Little did he think that within twenty-nine years there would be ten departments scattered from Coast to Coast, and practically all modeled after his at the time of his retirement from active teaching.

The Ceramic Schools

It is interesting, instructive, and somewhat surprising to note the following data with reference to the departments now in existence.

Ohio State University Columbus, Ohio

The course in Ceramics was first offered in 1894 as a two-year short course. In 1896 a full four-year course leading to a degree was offered.

To date this department has turned out 244 men in both courses, 171 having received degrees. It is worth noting that during the last ten years, 81 students have received degrees while but five have finished special or short courses, whereas during the first ten years of its existence this school granted ten degrees while 43 finished short or special courses.

Alfred University Alfred, New York

In 1900 Alfred University started the New York State School of Clay Working and Ceramics under the direction of Professor Charles F. Binns. This department offers a full engineering course leading to a degree, and has also specialized in art pottery and decorative ceramics, in which it has specially interested the women who are doing such good work in the preparatory schools of the country.

Unfortunately, statistics covering the number of students graduated are not available.

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[1] Presented at the Atlantic City Meeting of the AMERICAN CERAMIC SOCIETY, Atlantic City, N. J., February, 1924.

Iowa State College Ames, Iowa

A course in Ceramics was established at Ames in 1901. This course led to a degree. Development of this department has been rather slow but it has sent out into industry some splendid engineers.

Thirteen men have received degrees from this college. Six will receive degrees this year.

Rutgers College New Brunswick, New Jersey

In 1902 a ceramic school was established offering a full engineering course leading to a degree. This department has grown steadily if not rapidly. In this case also, statistics were not available.

University of Illinois Urbana, Illinois

In 1905, the University of Illinois instituted a a Department of Ceramics. This department has had rapid growth due principally to the strong support given it by the clayworkers of the state. A full engineering course is offered, leading to a degree.

To date this department has granted degrees to 95 men. It has also granted eight Master's and three Doctor's degrees.

Since 1913 this department has offered a two weeks' Short Course bi-annually. To date, 270 people interested in Ceramics have attended these sessions.

University of Washington, Seattle, Washington

A ceramics department was organized at this University in 1918, the first on the Pacific Coast. Teaching was not started until 1920. Since that time one graduate has received a Bachelor's degree, and three graduates, Master's degrees. Two students finished special courses last year.

University of Saskatchewan, Saskatoon, Canada

A department of ceramics was organized at this school in 1921 by Professor Worcester, one of Dr. Orton's first students. The course leads to an engineering degree. Two students, the first to enter the department, will graduate this year.

Three new ceramic departments are being established this year, two of them in the South. One of these is at Georgia Tech, Atlanta, one at North Carolina State College, Raleigh, and the other at Penn State, State College, Pa.

Thus on the twenty-ninth anniversary of the establishment of the school at Columbus, we have ten ceramic departments offering engineering degrees or the equivalent. These schools have sent into the various branches of the industry 350 engineers having degrees, approximately 150 men who have finished short or special courses and a considerable number of men who have received some training but for various reasons have not finished.

The curricula leading to degrees at the various schools have been very much alike basically. There have naturally been some variations, and

cases where emphasis has been put on some subjects more than others. In the main, however, it can be assumed, especially in late years, that the average graduate from each of the schools should be on a parity, in fact, actual comparisons show this to be pretty much the case.

It is needless to go into a discussion, before the members of this SOCIETY of the question as to whether the curricula laid out for ceramic students are properly designed. It is a question on which there is very little likelihood of agreement. Suffice it to say that even ceramic educators themselves are not entirely satisfied that they have reached the ideal. After all, it is not so much what subjects a man takes as how they are given to him, in other words, much depends on the instructors.

My purpose in this address is not to criticize our schools or their methods, but rather to analyze the men they are turning out, with special emphasis on those men who go into the operating departments.

The Encyclopedia Britannica defines a technical education as the special training which helps to qualify a person to engage in some branch of productive industry. It may be assumed then that our schools aim to give all the help possible to fit a ceramic engineer to take his place in industry, and it might also be assumed, with the least possible expense to his first employers.

I think it will be agreed that the task of developing a ceramic engineer is far more difficult than that of developing a mechanical, electrical, mining or civil engineer.

The latter branches of engineering have been taught so long that the educators have a well defined idea of what will be expected of the graduates, and, furthermore, the employers know what to expect of them.

In the ceramic industry, with its wide ramifications, there is such an immense gap between the requirements of an engineer in a spark plug plant, and a refractories engineer in a steel or copper plant, or the chemist of an optical glass plant, that it is difficult to train in more than fundamentals.

The question that occurs to many of us is whether sufficient stress is being laid on those fundamentals which will most quickly "sell" the graduate to his employer, and at the same time give him the shortest road to financial success.

During my service in the industry, I have had a splendid opportunity to study at close range, twenty-two men who have come to me directly from school. They were representatives of all but one of the older departments, and I believe, average representatives. All of these men preferred the operating to the laboratory or purely technical side of plant work.

When taking a young ceramic graduate into my employ, I have expected to find in him the following qualities:

(1) Accuracy.
(2) Absolute loyalty.
(3) A willingness to do whatever he was told.
(4) At least a sufficient knowledge of mechanics and things mechanical to warrant his title of engineer.
(5) A sufficient knowledge of psychology to allow him to understand labor.
(6) A working knowledge of drafting and designing.
(7) A knowledge of the chemistry and thermodynamics of fuel burning.

Somehow to the average man "accuracy" and "engineer" are synonymous. We can hardly think of an engineer as being inaccurate. I suppose we must assume that to a large extent a student's grades are a measure of his accuracy and that he must be fairly accurate to graduate.

From my personal experience, however, I am strongly of the belief that our schools are not impressing upon their students that "fairly accurate" will not do in industry. Very few of the young men I have come in contact with could, for example, be trusted to measure accurately pulley centers, and figure a belt length; get accurate data on a set of gears; or take an inventory, for months after they were employed and then only after constant criticism. Accuracy holds such an important place in any branch of modern business that it naturally occurs to one that a student should be so saturated with it that when he does leave school it will not be necessary to further impress its importance upon him. If it is possible to train a graduate to be accurate in from six to twelve months, is it not possible to train an undergraduate in four years?

I have never had the experience of having associated with me a disloyal college graduate. This may have been due to the kinship that one college man nearly always feels for another. Ceramic graduates, however, have often been placed in trying positions that have strained their loyalty to their superiors or employers to the breaking point. When such a point is reached, a man must be of fine fiber to be of further service. Loyalty is not included in the curriculum, but the ideal educator gives his students many things not so included.

Instances of the outcropping of disloyalty in graduates I have attributed to a lack of real knowledge of what was to be expected in the business world. I have often thought that great good could be derived from a series of lectures or talks by the older alumni during the senior year.

I have sometimes been brought, in my experience, to a point where I was inclined to agree with those opponents of a college education who maintain that many good men are ruined or partially ruined by it. Four years of easy campus life is not the best training in the world for an industry which operates twenty-four hours a day, and three hundred and sixty-five days in the year. In most cases the young graduate has a rude awakening

when he finds there are no more Saturdays, few Sundays, and that Thanksgiving and July 4th look like any other day in the year in many clay plants.

I cannot but feel that the failure on the part of graduates to grasp what industry will demand of them is due to a lack of proper training while in college. One thing is very noticeable, and that is that those men who have been trained by educators who have themselves been in the operating departments seem to go through the transition much better than others.

Every ceramic department has a few units of clay-working equipment, and yet it is surprising how little the average graduate knows about the equipment his training compels him to work with.

Every ceramic curriculum, I believe, provides for some training in mechanical engineering including the fundamentals of boiler, engine, and electrical apparatus construction and operation, also some training in forging and machine shop practice. From my own observation, I have been compelled to conclude that the value of this work is either insufficiently stressed or the work itself is slighted.

Undoubtedly, the forming of the great bulk of ceramic products has become mechanical, so much so in fact, that in the heavy clay products lines there are a greater number of failures due to the inability of the operators to keep up properly mechanical equipment than to inability to make a salable product. Many graduates having a splendid grounding in ceramic fundamentals have failed in their initial efforts because they were not well grounded in mechanical fundamentals. All the knowledge of glazes and glazing which a graduate might possess would not be one-tenth as valuable to him on a heavy clay products plant as the knowledge that a dry pan cannot be held together unless the bolts are equipped with lock washers or lock nuts, or that unless an elevator is operated at proper speed it will choke and cause constant shutdowns.

It seems almost absurd to employ an engineer who is not sure of the correct names of clay-working machines with which he is to work, and understands little or nothing of the principles upon which they operate. The same young man can invariably show some very good specimens of glazed pottery which he has turned out and which in later years prove to be constant reminders of time wasted.

Of equal importance to the mechanical side of ceramics is the ability of the young graduate to understand and direct labor. I have always been a strong believer in a thorough course in psychology as the best preparation possible for the man who aspires to an executive position.

Ceramic graduates are demanding and receiving salaries equal to department foremen, and whether employers are justified or not, they expect a college man to be able to handle a gang of laborers as well as or better than the average practical man. Executive ability may be a gift in some men, but I am convinced it can be acquired by others.

As success or failure today depends so largely on the labor factor it is of prime importance that operators know how to get the greatest efficiency from their men.

No course of training can be given a man in college, but a thorough grounding in psychology will go a long way toward giving him the right start.

Some of the departments are giving their students splendid courses in drafting and ceramic plant design, and the chemistry and thermodynamics of fuel burning, others are slighting these subjects. Too much stress cannot be laid upon the value of these subjects to the graduate who would become an operator.

I believe that the majority of our ceramic educators are agreed that the present curricula can be improved upon and that more time must be devoted to engineering fundamentals by students who intend to enter plant work.

It has been suggested that the curricula in all the departments be divided at the end of the sophomore year into science and engineering as is done at Illinois, except that there be even more concentration in engineering on those subjects which are closely related to plant control and administration. Such a course should cover at least 60% engineering fundamentals and practice. The ideal curriculum might even require the addition of a year for specialization, making five years, but this should be avoided if possible on account of the increasing cost of education and the crowded condition of the colleges.

Certain it is that scarcely a graduate can be found who has gone into plant work who does not severely criticize the present ceramic courses. If these men, who are the ones most interested, and the ones who are "buying" an education, are dissatisfied, is it not time for those in control of our educational institutions to awake to the fact that the present order of things must be changed?

WILLIAM LLOYD EVANS

America's First Collegiate Instructor in Ceramic Chemistry

When "Billy" Evans was instructor in ceramic chemistry the titles of Doctor, Major and Professor were not dreamed of. He was just "Billy" then and to the pupils now grown grey he is still just "Billy."

Professor Orton's budget did not permit employing a chemist the first year of the world's first collegiate department of ceramic education but in the second year he was able to employ an instructor, hence the advent of "Billy" Evans.

Analyzing of silicates is difficult today. Much more so was it thirty years ago when methods and reagents were less developed. Billy started his teaching when the chemical world was fast learning how to make silicate analysis, hence a merry time that first class had with their instructor. Trained with America's first ceramic chemist,

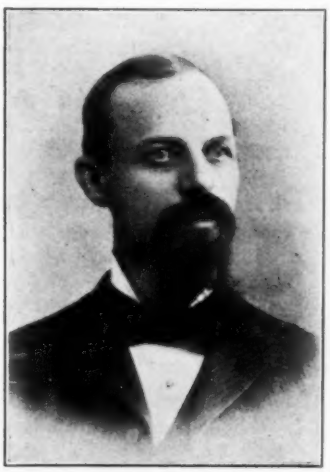
Karl Langenbeck, and further coached by that thorough chemical technician, Edward Orton, Jr., Billy was able to keep in the lead albeit closely pursued by his pupils.

This our "Billy," we present as America's first collegiate instructor of ceramic chemistry. Celebrating as we are this month, the beginnings of collegiate ceramic education, it is fitting that we, the first pupils, should want our "Billy" on the map.

WILLIAM LLOYD EVANS

He was born December 22, 1870, Columbus, Ohio. Public school education in Columbus, graduated at Ohio State University, 1892, with B.Sc. degree; M.Sc. in 1896 from same institution; Ph.D. from the University of Chicago in 1905. Was assistant chemist to Karl Langenbeck, American Encaustic Tiling Co., Zanesville, Ohio, 1892–1894. Assistant in Department of Ceramics under Professor Edward Orton, Jr., Ohio State University, 1896–1898; teacher in Chemistry in Colorado Springs High School, 1898–1902; Assistant Professor of Chemistry, Ohio State University, 1905–1907; Associate Professor, 1907–1911; Professor of Chemistry, since 1911.

Entered the Ordnance Department, United States Army as Captain in October 22, 1917. Transferred to Chemical Warfare Service after the organization of this service, being promoted to the rank of Major, July 20, 1918. While in the service he was given the responsibility of building, organizing, equipping, and operating Chemical Laboratory, Edgewood Arsenal, Edgewood, Maryland, and was the scientific and executive head of the Laboratories and Inspection Division, Offense Division, Chemical Warfare Service, Edgewood Arsenal, at the time of the signing of the Armistice.



JAMES H. GOODWIN

JAMES H. GOODWIN

James H. Goodwin gave Professor Orton a large amount of very effective assistance in aligning the Ohio general ware manufacturers and presenting claims to the state legislature in support of the proposals of a school of ceramics at the Ohio State University. It was the personal approval and active backing of such men as James H. Goodwin that made possible the beginning of collegiate ceramic education in America.

Mr. Goodwin was born in East Liverpool, Ohio, July 3, 1846, and died Nov. 4, 1896. His father was John Goodwin from the Staffordshire district, England. John Goodwin, the father, began manufacturing yellowware and rockingham in East Liverpool in 1842, four years before the birth of James. With his brothers George S., and Henry S. Goodwin, James began the production of whiteware in 1876.

In addition to his support of Professor Orton's scheme for a ceramic school we are indebted to James Goodwin for having introduced the use of the pugmill. Prior to his obtaining a pugmill used in a paper pulp mill in Wisconsin they used the horse propelled "chaser pan."

It is said of James H. Goodwin that he was at all times ready to give information and assistance to his competing potters. He believed his business would not be harmed nor made more difficult if all potters made as excellent ware as was possible from their pooled experiences and knowledge. His ideals and practices were the same as those which have made this Society successful.

We acknowledge our obligation to the broad generous vision and helpfulness of James H. Goodwin. It is in keeping with his helpful spirit that his son Charles F. Goodwin is serving as Secretary of the U. S. Potters Association.

ACTIVITIES OF THE SOCIETY

OUR 1924 FISCAL RECORD

In the accompanying sheets are statements of the financial affairs of the SOCIETY. The SOCIETY operated during 1924 within the prescribed budget and at a financial profit.

After depreciating the inventories, paying all known charges, and not including any unpaid membership fees, the surplus, representing profits, furniture and inventories is $10,379.60.

The SOCIETY realized a net profit of $2929.12, of which $400 is cash and $2529.12 readily collectable accounts receivable.

Charged to this year's business is $970.05 representing the net cost to the SOCIETY of the Silica and Magnesite Refractories Bibliographies and $698.55 for the printing of the 1922 *Journal* Index. These two items, totalling in cost $1668.60 represents services rendered in excess of what was expected by the members.

A large item of financial loss as well as being a large loss in effectiveness is represented by $2183.05 dues for 1924 not received. This large non-payment of dues is regrettable more because it represents a loss in contacts and opportunities for extension of service. The SOCIETY needs the support of these delinquent members more for what they represent in opportunity to spread and to obtain information than for the fees they have not paid. Then, too, with the fees they should have paid, the SOCIETY could have extended its activities, supported research activities and in many ways better carried out the purposes for which it is maintained.

Rather than pride in the things accomplished the members should seriously consider what this loss in members means. Prompt payment of membership dues on receipt of statement insures continued service to the member and less expense to the SOCIETY. The money used in collecting delinquent dues would go quite a way in support of a research activity, the value of which would exceed the dues collected.

Our membership record for 1924 is as here shown. This record has been maintained without any special drive or urging.

	PERSONAL				CORPORATION			
Time period	Beginning	Loss	Added	Net standing	Beginning	Loss	Added	Net standing
Dec. 15–Jan. 15	1959		31	1990	290		6	296
Jan. 15–Feb. 15	1990		41	2031	296		8	304
Feb. 15–Mar. 15	2031	68	29	1992	304	5		299
Mar. 15–Apr. 15	1992	7	35	2020	299	2	3	300
Apr. 15–May 15	2020	214	25	1831	300	13	4	291
May 15–June 15	1831	13	18	1836	291		3	294
June 15–July 15	1836	1	14	1849	294		3	297
July 15–Aug. 15	1849	1	9	1857	297			297
Aug. 15–Sept. 15	1857		9	1866	297			297
Sept. 15–Oct. 15	1866	2	17	1881	297		2	299
Oct. 15–Nov. 15	1881	2	11	1890	299		2	301
Nov. 15–Dec. 15	1890	3	11	1898	301			301
Net Loss				61				
Net Gain								11
Delinquent for 1924		213				6		
Members in good standing Jan. 1	1685				295			
Dec. 15–Jan. 15	1898	29	24	1893	301	7	1	295

The SOCIETY must strive to hold our members and to obtain more, not to have numbers but to increase the service contacts. If the services rendered by the SOCIETY is worth to the few what it costs in money and effort the worth of these services would be increased additively with each increase in number of members.

AMERICAN CERAMIC SOCIETY

CASH ACCOUNT

January 1, 1924 to December 31, 1924

RECEIPTS		
Free Balance in Bank January 2, 1924	$ 4,076.66	
Accounts Receivable Paid	1,647.88	
Advertising, Refractories Bibliography	303.00	
1925 dues paid in advance	5,646.06	
1925 JOURNAL paid in advance	883.94	
Advertising 1924 JOURNAL	14,068.55	
Dues 1924	14,526.52	
Publications Sold:		
Collective Index	17.62	
Journals	2,733.33	
Seger's Collected Writings	124.50	
Volumes Transactions	222.50	
Report Committee on Standards	27.80	
Reprints	766.09	
Interest	199.75	
Meeting expense refunded	28.44	
Postage refunded	12.50	
Traveling refunded	350.00	
Miscellaneous	30.11	45,665.25
DISBURSEMENTS		
Office equipment purchased	166.45	
Checks returned	18.20	
Printing Refractories Bibliography	1,226.00	
Stenographic help on Clay Bibliography	100.00	
Dues and JOURNAL refund	138.45	
Division expense:		
Art	190.45	
Enamel	229.55	
Glass	159.67	
Heavy Clay Products	191.63	
Refractories	301.68	
Terra Cotta	161.21	
White Ware	194.30	
Advertising expense	1,662.01	
1924 JOURNAL, Cost	15,790.62	
Abstracts, Cost	523.29	
1922 Index, Cost	698.55	
Reprints, Cost	1,780.92	
Seger's Writings, Cost	78.71	
Volumes Transactions, Cost	20.00	
Salaries	11,313.78	
Office Expense		
Secretary	3,352.34	
Editor	1,017.33	
President	34.25	
Treasurer	5.15	
Traveling	813.03	
Traveling refunded	350.00	1,163.03
Meetings	1,550.84	
Committee expense	42.88	
Art Exhibit	183.21	
Miscellaneous	141.75	42,436.25
Balance in Bank		3,229.00
		45,665.25

This is to certify that I have checked all receipts (both direct and from the General Secretary) as shown by the Treasurer's Cash Book and have traced them through the deposits into the bank and all disbursements represented by vouchers except those outstanding have been carefully checked as to amounts and official signatures and found correct.

ASA J. HATCH, *Public Accountant.*

AMERICAN CERAMIC SOCIETY

BALANCE SHEET

December 31, 1924

	Trial Balance		One Year		January 1, 1925	
	Dr.	Cr.	Loss	Gain	Assets	Liabilities
Cash in Bank	3,229.00				3,229.00	
Cash, petty	300.00				300.00	
Liberty Bonds	4,700.00				4,700.00	
Furniture and Fixtures	1,119.33		111.93		1,007.40	

BALANCE SHEET (*Continued*)

	Trial Balance Dr.	Trial Balance Cr.	One Year Loss	One Year Gain	January 1, 1925 Assets	January 1, 1925 Liabilities
Accounts Receivable:						
Adv. JOURNAL 1,986.60						
Adv. Bib. 99.00						
Pubs. 444.20	2,529.80				2,529.80	
Prepaid Expense, Clay Bib.	100.00				100.00	
Prepaid Dues, Personal		3,069.16				3,069.16
Prepaid Dues, Corp'n.		2,057.50				2,057.50
Prepaid Dues, Divisions		511.90				511.90
Prepaid Journals		873.84				873.84
Divisions:						
Art	190.45	70.05	120.40			
Enamel	229.55	309.93		80.38		
Glass	159.67	262.42		102.75		
H. C. P.	191.63	239.88		48.25		
Refractories	301.68	392.76		91.08		
Terra Cotta	161.21	114.00	47.21			
White Wares	194.30	580.68		386.38		
Income:						
Advertising		15,986.90		15,986.90		
Dues—Personal		14,895.52		14,895.52		
Dues—Corp'n.		6,526.00		6,526.00		
Coll. Indexes		19.12				
Coll. Indexes Inv.	120.00			17.92	118.80	
Journals 1918–1923		621.11				
Journals 1918–1923 Inv.	4,202.80			446.51	4,028.20	
JOURNAL 1924		2,783.74		2,783.74		
Reprints		1,031.71		1,031.71		
Seger's Writings		124.50		124.50		
Transactions		272.50				
Transactions Inv.	715.00			182.50	625.00	
Rep. Com. Std.		35.05				
Rep. Com. Std. Inv.	85.00			27.05	77.00	
Interest on Lib. Bonds		199.75		199.75		
Miscellaneous		38.69		38.69		
Expenses:						
Adv. Comm.	1,662.01		1,662.01			
JOUR. 1924 Printing	15,790.62		15,613.82			
JOUR. 1924 Inv.					176.80	
Abstracts	523.29		523.29			
1922 Indexes Printing	698.55		698.55			
Reprints	1,780.92		1,780.92			
Seger's Writings	78.71		78.71			
Vol. Trans.	20.00		20.00			
Bib. Refractories	1,372.05	402.00	970.05			
Salaries	11,313.78		11,313.78			
Office Exp. Sec'y.	3,339.84		3,339.84			
Office Exp. Editor	1,017.33		1,017.33			
Office Exp. Pres.&Treas.	39.40		39.40			
Traveling Expense	813.03		813.03			
Meetings Expense	1,522.40		1,522.40			
Committee Expense	42.88		42.88			
Art Exhibit Expense	183.21		183.21			
Miscellaneous Expense	141.75		141.75			
Profit for year			2,929.12			10,379.60
Surplus		7,450.48				
	58,869.19	58,869.19	42,969.63	42,969.63	16,892.00	16,892.00

AMERICAN CERAMIC SOCIETY

LOSS AND GAIN STATEMENT

January 1, 1924 to December 31, 1924

GAINS

Earned Dues			21,421.52
Indexes Collective			17.92
Interest on Liberty Bonds			199.75
Miscellaneous			38.69
Net Gain on Divisions			541.23
JOURNALS 1918 to 1923, Sales		621.11	
Less decrease in inventories		174.60	
Net Gain			446.51
JOURNALS 1924, Sales		2,783.74	
Advertising	15,986.90		
Less Commission	1,662.01	14,324.89	
Total		17,108.63	
Printing	15,613.82		
Abstracts	523.29	16,137.11	
Net Gain			971.52
Seger's Writings, Sales		124.50	
Cost		78.71	
Net Gain			45.79

GAINS (continued)

Vol. of Transactions		272.50		
Cost	20.00			
Less decrease in inventory	90.00	110.00		
Net Gain			162.50	
Reports of Com. on Standards, Sales		35.05		
Less decrease in inventory		8.00		
Net Gain			27.05	23,872.48

LOSSES

Reprints—Cost	1,780.92		
Sales	1,031.71		
Net Loss		749.21	
Bibliographies, Refractories—Cost	1,372.05		
Income	402.00		
Net Loss		970.05	
Printing 1922 Indexes		698.55	
Expenses:			
Salaries	11,313.78		
Office Expense—Secretary	3,339.84		
Editor	1,017.33		
President and Treasurer	39.40		
Traveling Expense	813.03		
Meetings Expense	1,522.40		
Committee Expense	42.88		
Art Exhibit Expense	183.21		
Miscellaneous Expense	141.75		
Total		18,413.62	
Depreciation on Furniture and Fixtures		111.93	
Total Net Losses			20,943.36
Net Gain for Year			2,929.12

AMERICAN CERAMIC SOCIETY

FINANCIAL STATEMENT

January 1, 1925

ASSETS

Cash in Bank	3,229.00		
Cash, Petty	300.00	3,529.00	
Liberty Bonds		4,700.00	
Accounts Receivable:			
Advertising, JOURNAL	1,986.60		
Advertising, Bibliographies, Ref.	99.00		
Publications	444.20	2,529.80	
Furniture and Fixtures	1,119.33		
Depreciation 10%	111.93	1,007.40	
Inventories—Publications:			
Indexes, Collective 1,188 at 10 cents	118.80		
JOURNALS 1918–1923 40,282 at 10 cents	4,028.20		
JOURNALS 1924 1,768 at 10 cents	176.80		
Vol. Transactions 250 at $2.50	625.00		
Reports Com. Stds. 770 at 10 cents	77.00	5,025.80	
Prepaid Expenses—Clay Bibliographies		100.00	
Total Assets			16,892.00

LIABILITIES

Notes Payable		none	
Prepaid Dues—Personal	3,069.16		
Corporation	2,057.50		
Divisions	511.90	5,638.56	
JOURNALS		873.84	
Total Liabilities			6,512.40
Surplus January 1, 1924		7,450.48	
Gain for year 1924		2,929.12	
Surplus—Assets over Liabilities—January 1, 1925			$10,379.60

THE SOCIETY WANTS CERAMIC WORKERS

Twenty-four personal members and one corporation is the record of our membership workers for the past month. If you will note the occupations of these new members you will see that everyone of them is actively engaged in ceramic pursuits and that everyone of them not only needs the backing of the AMERICAN CERAMIC SOCIETY, but is an active, vital ceramic thinker adequate for the enriching of the ceramic world.

You are working an injustice to your friends and acquaintances who would serve and benefit mutually by a membership in this SOCIETY, if you do not invite them. The

following letter from Dr. Silverman of Pittsburgh will show those who have not "gotten into the swing," how new members are obtained. Note that his applicants were men "especially interested in glass." That is what we want: vital members, alive and full of questions and searchings for ceramic facts.

"MY DEAR PURDY:

I had three Russian visitors this morning who were interested in glass, so I took occasion to enroll them for membership in the AMERICAN CERAMIC SOCIETY. Their application cards are inclosed herewith."

Another letter from H. W. Mauser, Jr., of Delft, Holland, illustrates a similar spirit of coöperation.

Koninklijke Delftsch-Aardewerkfabriek "De Porceleyne Fles"

Delft, 16 Nov., 1924

MR. R. C. PURDY,
Secretary, AMERICAN CERAMIC SOCIETY,
Columbus, Ohio.

MY DEAR SIR:

On re-reading your letter of Sept. 10, including your call for some of our energy for the benefit of the SOCIETY and its members, I regretted not being able at the time to write an article for the *Journal*.

Plans there are enough, but not the time to work them out, as we have, happily, an extremely busy time at our factory.

So I came to point two. Perhaps there was an opportunity to do my bit. The August-September list of new members, showing only nine names, showed the necessity of going to deliver a speech to "that friend of mine" you referred to.

So I went over to him. The result you will find enclosed in this letter.

It is a pity Columbus is a little far away for us to come over for a few days only, probably there will come a time, that affairs can be combined, and that I will be able to attend to one of the big "Ceramic Society" Meetings.

Most truly yours,

H. W. MAUSER, JR., *Secretary*.

Speak to that co-worker of yours who is not a member of the SOCIETY. He needs the SOCIETY and the SOCIETY needs him.

NEW MEMBERS RECEIVED FROM DECEMBER 15 to JANUARY 15

PERSONAL

J. O. Benson, Carr-Lowrey Glass Co., Baltimore, Md.

Robert C. Boyd, 700 Center St., Waukegan, Ill. Ceramic Engineer, Chicago Hardware Foundry Co., North Chicago, Ill.

H. L. Brooks, 1658 St. Charles Rd., Cleveland, Ohio, Ferro Enameling Co.

Clarence L. Deeds, Laboratory Asst., Homer-Laughlin China Co., Newell, W. Va.

H. E. Ebright, 1533 Cohassett St., Cleveland, Ohio. Ferro Enameling Co.

Worth S. Elton, Supt., Lyth Tile Corp., Angola, N. Y.

S. Enomoto, Higher Technical School, Tokio, Japan.

Edward C. Greenstreet, Carr-Lowrey Glass Co., Baltimore, Md.

H. J. Ivanowsky, Charkow, Chimougol, Rimarskaia 22, Russia. Chief Engineer, Konstantinowka Glass Works.

W. S. Jacopson, Trust Chimougol, Charkow, Rimarskaia 22, Russia. Managing Director, Lisitshansk Glass Works.

Walter A. King, Laboratory Asst., Pfaudler Co., Elyria, Ohio.

N. F. Krassnikoff, Moscow, Russia, Miasnitzkaia 8. Technical Director, All Russian Silicate Syndicate.

Gordon S. Lindsey, Industrial Fellow, Mellon Institute, Pittsburgh, Pa.

James T. MacKenzie, 4300 Glenwood Ave., Birmingham, Ala., Metallurgist and Chief Chemist, American Cast Iron Pipe Co.

Wilfrid Mavor, 145 Isabella St., Toronto, Canada, Ferro Enameling Co.

Joseph Weir McHugh, 1522 Union St., Schenectady, N. Y. Exptl. Asst., Porcelain Dept., General Electric Co.

Frank L. Michael, 1522 Union St., Schenectady, N. Y. Electrical porcelain, General Electric Co.

Howard S. Orth, 416 Majestic Bldg., Columbus, Ohio. Harrop Tunnel Kilns.

Donald Wolf Randolph, 1106 Church St., Flint, Mich. Research Engineer, A.-C. Spark Plug Co.

W. Leslie Sample, 515 North 9th St., Cambridge, Ohio. Chief (1) Inspector and (2) Research Dept., Cambridge Sanitary Mfg. Co.

Ernest C. Schmatolla, P. O. Box 185, Flint, Mich. Library technologist, A.-C. Spark Plug Co.

Gustav von den Steinen, 2568 Euclid Blvd., Cleveland Heights, Ohio. Vice-president, The Glascote Co., Euclid, Ohio.

Arthur Q. Tool, Physicist, Bur. of Standards, Washington, D. C.

Wolfgang Zöller, Kotzenau Kreis Lüben, Germany. General director of the Iron and Enamel Works, Marienhütte.

CORPORATION

Carl B. Harrop, Engineers and Constructors, 416–19 Majestic Bldg., Columbus, Ohio. C. B. Harrop, Representative.

Membership Workers' Record

	Personal	Corporation		Personal
C. E. Bales	1		S. J. McDowell	2
L. E. Barringer	2		E. P. Poste	1
A. V. Bleininger	1		Frank G. Roberts	1
M. W. Butler	1		A. Silverman	3
J. E. Hansen	1		Bruce F. Wagner	1
C. B. Harrop	1	1	R. A. Weaver	3
R. W. Jones	1		H. G. Wolfram	1
W. Keith McAfee	1		Office	3
			Total	25

PRESENT ADDRESSES UNKNOWN

NOTE: Kindly notify the Secretary of the SOCIETY if you know the correct address of any of the members listed herewith.

All-in-One Plumbing Fixture Corp., 231 Ochsner Bldg., Sacramento, Calif.

Frank Baddeley, 206 E. California St., Walnut Park, Glendale, Calif.

G. V. Baker, Supt. Penna. Feldspar Co., Barnard, N. Y.

Leo T. Butman, F. R. Muller & Co., Waukegan, Ill.

J. P. Callaghan, care of Teaque Hotel, Montgomery, Ala.

T. M. Caven, 564 W. 173d St., New York, N. Y.
August F. Danes, Laclede-Christy Clay Prod. Co., St. Louis, Mo.
Frank M. Didisheim, 234 Union St., Schenectady, N. Y.
Charles S. Dolley, Keramoid Mfg. Co., Fort Madison, Iowa.
S. P. Edson, Bryantville, Mass.
M. S. Gifford, Lake Bluff, Ill.
A. H. Goodman, Box 915, Pittsburgh, Pa.
Fred W. Greenlee, Linerville, Iowa.
John L. Greenwood, Supt., Lehigh Sewer Pipe & Tile Co., Lehigh, Iowa.
C. Knox Harding, 6318 Stony Island Ave., Chicago, Ill.
S. B. Henshaw, Libbey-Owens Sheet Glass, Toledo, Ohio.
Kenneth E. Holley, Alfred, New York.
Edgar Jones, 35 Rimbach Ave., Hammond, Ind.
J. M. Knote, J. M. Gautier & Co., Green & Essex Sts., Jersey City, N. J.
Roy Lacy, 634 S. St. Andrews Pl., Los Angeles, Calif.
Arthur T. Leahy, 5490 Ellis Ave., Chicago, Ill.
Wm. W. Lemmax, Box 59, Taylor, Wash.
Geo. W. Lester, 2176 McClellan Ave., Detroit, Mich.
F. G. Lord, Pa. Pulverizing Co., 341 4th Ave., Pittsburgh, Pa.
Joseph A. Maguire, 440 Martel St., Bethlehem, Pa.
A. T. Meldram, Strathcona Potteries, 99 St. James St., Montreal, Canada.
C. F. Miller, Univ. of Washington, Law School, Seattle, Wash.
F. H. Nies, Cor. Hamilton Ave. & Summit St., Brooklyn, N. Y.
H. M. Pulsifer, Geo. H. Holb & Co., Chicago, Ill.
Paul Q. Quay, Lake Shore Blvd., Euclid, Ohio.
A. E. Saunders, 48 Albermarle Ave., Toronto, Ontario.
A. Lincoln Scott, Auditorium Tower, Chicago, Ill.
Lee Showers, Pittsburgh Plate Glass Co., Pittsburgh, Pa.
Geo. O. Smith, Carr-Lowrey Glass Co., Baltimore, Md.
Clarence A. Stimpson, Chicago Pneumatic Tool Co., Century Bldg., Chicago, Ill.
Chas. H. Stone, Jr., 1210 Oak St., Jacksonville, Fla.
Miss Evelyn Tennyson, Alfred University, Alfred, N. Y.
Erwin F. Theobald, General Delivery, Bessemer, Pa.
Boris Trifonoff, 631 Putnam Ave., Zanesville, Ohio.
Frank A. Weidman, 38 S. Dearborn St., Chicago, Ill.
G. N. White, Sc.D. 7 Victoria Ave., Worcester, England.
E. J. Winkleman, American Refractories Co., Pittsburgh, Pa.
Miles M. Zoller, 208 S. La Salle St., Chicago, Ill.

MEMBERSHIP LIST[1]

P. A. Adams, Mansfield Vitreous Enameling Co., Mansfield, Ohio.—E.
A. O. C. Ahrendts, Atlas China Co., Niles, Ohio.—W. W.
Lewis Albrecht, General Ceramics Co., 50 Church St., New York, N. Y.—H. C. P.
L. R. W. Allison, The Ceramist, Newark, N. J.

[1] This list includes all members of the SOCIETY representing corporation memberships. The initial following the name indicates the Division to which the member belongs, as follows: (A) Art; (E) Enamel; (G) Glass; (H. C. P.), Heavy Clay Products; (R) Refractories; (T. C.), Terra Cotta; (W. W.), White Wares. No initial following the name indicates that the member is unclassified.

[1] ————, American Terra Cotta & Ceramic Co., 1808 Prairie Ave., Chicago, Ill.—T. C.
Jos. L. Anthony, Glenwood Range Co., Taunton, Mass.—E.
Thos. F. Armstrong, Conkling-Armstrong Terra Cotta Co., Wissahickon & Juniata, Philadelphia, Pa.—T. C.
D. C. Asper, Penn Tile Works Co., Inc., Aspers, Pa.—A.
A. J. Aupperle, American Rolling Mill Co., Middletown, Ohio.—E.
E. B. Ayres, Proctor & Schwartz, Inc., 7th St. & Tabor Rd., Philadelphia, Pa.

Robert Back, The Wahl Co., Chicago, Ill.—R.
George S. Bacon, Whitall-Tatum Co., Millville, N. J.—G.
Frank A. Bailey, DeVilbiss Mfg. Co., Toledo, Ohio.—E.
W. G. Baker, Baker Bros. Glass Co., Okmulgee, Okla.—G.
A. P. Ball, Square D Co., Peru, Ind.—W. W.
George A. Ball, Ball Brothers Co., Muncie, Ind.—G.
Ernest A. Batchelder, Batchelder-Wilson Co., 2633 Artesian St., Los Angeles, Calif.—W. W.
F. W. Beach, Mansfield Sheet & Tin Plate Co., Mansfield, Ohio.—E.
H. L. Beach, Beach Enameling Co., Coshocton, Ohio.—E.
D. A. Benson, Big Savage Fire Brick Co., Frostburg, Md.—R.
C. A. Blackburn, Cleveland Metal Prod. Co., Cleveland, Ohio.—E.
H. H. Blau, Macbeth-Evans Glass Co., Eastern Division, Charleroi, Pa.—G.
C. H. Blumenauer, Jefferson Glass Co., Follansbee, W. Va.—G.
W. E. Bockman, J. A. Bauer Pottery Co., Los Angeles, Calif.—A.
L. H. Bown, Buffalo Pottery, Buffalo, N. Y.—W. W.
W. T. Brangham, Falcon Tin Plate Co., Niles, Ohio.—E.
Chas. Brian, Paper Makers Importing Co., Inc., Easton, Pa.—W. W.
G. S. Bryce, Bryce Bros. Co., Mt. Pleasant, Pa.—G.
A. W. Buckingham, Russell Engineering Co., 1624 Ry. Exchange Bldg., St. Louis, Mo.—R.
J. A. Buckwalter, Buckwalter Stove Co., Royersford, Pa.—E.
J. T. Bunn, U. S. Sanitary Mfg. Co., Monaca, Pa.—E.
S. G. Burt, The Rookwood Pottery Co., Cincinnati, Ohio.—A.
F. W. Butler, Mogadore Insulator Co., Mogadore, Ohio.—W. W.
Louis L. Byers, Abrasive Co., Tacony & Fraley Sts., Philadelphia, Pa.—R.

John A. Campbell, The Trenton Potteries, Trenton, N. J.—W. W.
John H. Cavender, Chicago Retort & Fire Brick Co., 208 S. La Salle St., Chicago, Ill.—R.
R. L. Cawood, The Patterson Foundry & Machine Co., East Liverpool, Ohio.—W. W.
M. J. Cereghino, Los Angeles Gas & Elec. Corp., Los Angeles, Calif.—R.
G. Oliver Challinor, U. S. Glass Co., S. 9th St., Pittsburgh, Pa.—G.
Thomas Chester, American Blower Co., 6004 Russell St., Detroit, Mich.
H. H. Clark, The Peoples Gas Light & Coke Co., Chicago, Ill.—R.
A. E. Clarke, Benjamin Electric Mfg. Co., Des Plaines, Ill.—E.
Ray Y. Cliff, Saxon China Co., Sebring, Ohio.—W. W.
F. J. Clifford, Chicago Pottery Co., 1924 Clybourn Ave., Chicago, Ill.—W. W.
S. S. Cochrane, Owens Bottle Co., Toledo, Ohio.—G.
L. S. Collins, Los Angeles Brick Co., 514 Security Bldg., Los Angeles, Calif.—H. C. P.
F. R. Corwin, U. S. Metals Refining Co., Carteret, N. J.—R.

[1] Company has named no representative.

C. W. Crane, Crossman Co., South Amboy, N. J.—H. C. P.
J. F. Creegan, California Pottery Co., 579 Mills Bldg., San Francisco, Calif.—H. C. P.
D. M. Cronin, Standard Pottery Co., E. Liverpool, Ohio.—W. W.
J. W. Cruikshank, J. W. Cruikshank Eng. Co., Pittsburgh, Pa.—G.
W. E. Cunning, West End Pottery Co., East Liverpool, Ohio,—W. W.
M. F. Cunningham, Waltham Grinding Wheel Co., Waltham, Mass.—R.
R. T. Cunningham, Monongah Glass Co., Fairmont, W. Va.—G.
W. F. Curtis, Fostoria Glass Co., Moundsville, W. Va.—G.

I. F. Dains, Western Stoneware Co., Monmouth, Ill.—W. W.
Richard F. Dalton, New York Architectural Terra Cotta Co., Long Island City, N. Y., —T. C.
A. Davidson, Crown Potteries Co., Evansville, Ind.—W. W.
J. A. De Celle, Chicago Hardware Foundry Co., N. Chicago, Ill.—W. W.
J. M. Dell, Missouri Fire Brick Co., St. Louis, Mo.—R.
W. F. Demuth, The Canton Brick & Fireproofing Co., New Philadelphia, Ohio.—H. C. P.
N. A. Dickey, Livermore Fire Brick Wks., 604 Mission St., San Francisco, Calif.—R.
Geo. W. Dilks, Jr., Seaboard Fuel Corp., 1610 Spruce St., Philadelphia, Pa.
Chas. E. Doll, Mt. Clemens Pottery Co., Mt. Clemens, Mich.—W. W.
H. S. Donaldson, Enterprise White Clay Co., Philadelphia, Pa.—W. W.
B. F. Drakenfeld, Jr., B. F. Drakenfeld & Co., New York City.
B. F. Dunn, Dunn Wire Cut Lug Brick Co., Conneaut, Ohio.—H. C. P.
E. M. Durant, The Pacific Clay Prod., Inc., Los Angeles, Calif.—H. C. P.
Emmet Dwyer, Michigan Stove Co., Detroit, Mich.—E.

T. C. Eayrs, Massillon Stone & Fire Brick Co., Massillon, Ohio.—R.
D. R. Edgar, Edgar Plastic Kaolin Co., Metuchen, N. J.—W. W.
Howard P. Eells, Jr., Dolomite Products Co., Cleveland, Ohio.—R.
C. C. Engle, United Clay Mines Corporation, Trenton, N. J.—W. W.
B. K. Eskesen, Matawan Tile Co., Matawan, N. J.—W. W.
E. V. Eskesen, N. J. Terra Cotta Co., New York City.—T. C.
M. Ezoi, Nippon Gaishi Kwaisha, Atsuta Higashimatch, Nagoya City, Japan.—W. W.

Geo. P. Fackt, Denver Terra Cotta Co., Denver, Colo.—T. C.
Kenneth C. Farnsworth, Roberts & Mander Stove Co., Hatboro, Pa.—E.
[1] ————, Findlay Clay Pot Co., Washington, Pa.—G.
G. F. Fiske, American Stove Co., St. Louis, Mo.—E.
Herbert Forester, Veritas Firing System, Trenton, N. J.—W. W.
Arthur D. Forst, Robertson Art Tile Co., Trenton, N. J.—W. W.
W. H. Foster, National Fireproofing Co., 1126 Fulton Bldg., Pittsburgh, Pa.—R.
C. D. Fraunfelter, Fraunfelter China Co., Zanesville, Ohio.—W. W.
C. E. Frazier, Simplex Engineering Co., Washington, Pa.—G.
[1] ————, Friderichsen Floor & Wall Tile Co., Independence, Mo.—W. W.
[1] ————, Frink Pyrometer Co., Lancaster, Ohio.—G.
E. H. Fritz, Westinghouse High Voltage Insulator Co., Derry, Pa.—W. W.
Howard Frost, Los Angeles Pressed Brick Co., Los Angeles, Calif.—R.
C. E. Fulton, The Pittsburgh Plate Glass Co., Pittsburgh, Pa.—G.

W. I. Gahris, Limoges China Co., Sebring, Ohio.—W. W.
Richard W. Gass, U. S. Smelting Furnace Co., Belleville, Ill.—E.

[1] Company has named no representative.

H. B. Gates, The Armstrong Cork & Insulation Co., Pittsburgh, Pa.—W. W.
M. E. Gates, Clay Service Corp., Chicago, Ill.
W. J. Geddes, Denver Sewer Pipe & Clay Co., Denver, Colo.—H. C. P.
Carl Geist, Geist Mfg. Co., 2001 Atlantic Ave., Atlantic City, N. J.
W. C. George, Canonsburg Pottery Co., Canonsburg, Pa.—W. W.
W. C. George, W. S. George Pottery Co., East Palestine, Ohio.—W. W.
Jas. Gillinder, Gillinder Bros., Port Jervis, N. Y.—G.
A. Goetz, Jointless Fire Brick Co., 1130 Clay St., Chicago, Ill.—R.
Chas. E. Golding, Golding-Keene Co., Keene, N. H.—W. W.
Sigmund Goldman, English China Clays Sales Corp., 33 W. 42nd St., New York, N. Y.—W. W.
Werner H. Grabbe, Columbian Enameling & Stamping Co., Terre Haute, Ind.—E.
R. F. Grady, St. Louis Terra Cotta Co., St. Louis, Mo.—T. C.
C. O. Grafton, Gill Clay Pot Co., Muncie, Ind.—G.
E. H. Graham, Washington Iron Works, Los Angeles, Calif.—E.
De Forest Grant, Federal Terra Cotta Co., New York City.—T. C.
J. L. Green, Laclede-Christy Clay Products Co., St. Louis, Mo.—R.

E. H. Haeger, The Haeger Potteries, Inc., Dundee, Ill.—W. W.
J. W. Hall, The Westport Paving Brick Co., Baltimore, Md.—H. C. P.
Lee Hall, Federal Electric Co., 8700 S. State St., Chicago, Ill.
W. L. Hanley, Jr., Bradford Brick & Tile Co., Bradford, Pa.—H. C. P.
Abel Hansen, Fords Porcelain Works, Perth Amboy, N. J.—W. W.
E. O. Harbeck, Challenge Refrigerator Co., Grand Haven, Mich.
Harlowe Hardinge, Hardinge Co., Inc., York, Pa.
Carl B. Harrop, C. B. Harrop Co., 416 Majestic Bldg., Columbus, Ohio.—H. C. P.
W. A. Harshaw, Harshaw Fuller & Goodwin Co., 545 Hanna Bldg., Cleveland, Ohio.
Isaac Harter, Babcock & Wilcox Co., 85 Liberty St., New York, N. Y.—R.
Hamilton Hazelhurst, Old Bridge Enameled Brick & Tile Co., Old Bridge, N. J.—W. W.
Jos. Heidenkamp, Heidenkamp Plate Glass Co., Springdale, Pa.—G.
A. C. Held, Rundle Mfg. Co., Milwaukee, Wis.—E.
F. R. Henry, The A. A. Simonds-Dayton Co., Dayton, Ohio.—R.
W. H. Herbert, W. G. Bush & Co., 174 Third Ave., N., Nashville, Tenn.—H. C. P.
R. P. Herrold, Mosaic Tile Co., Zanesville, Ohio.—W. W.
R. F. Hess, Crescent Refractories Co., Curwensville, Pa.—R.
James H. Hill, Alberhill Coal & Clay Co., Alberhill, Calif.—H. C. P.
W. B. Hitchcock, Portsmouth Refractories Co., Portsmouth, Ohio.—R.
E. F. Hoerger, Canton Stamping & Enameling Co., Canton, Ohio.—E.
A. A. Holmes, American Trona Corp., 233 Broadway, New York, N. Y.—A.
Lee Holtz, So. California Gas Co., 950 Broadway, Los Angeles, Calif.
W. F. Hosford, Western Electric Co., Hawthorne Sta., Chicago, Ill.—W. W.
A. F. Hottinger, Chicago Crucible Co., 2525 Clybourn Ave., Chicago, Ill.—R.
A. F. Hottinger, Northwestern Terra Cotta Co., Chicago, Ill.—T. C.
Roger J. Houze, L. J. Houze Convex Glass Co., Point Marion, Pa.—G.
R. D. Humphreys, Mississippi Glass Co., 220 Fifth Ave., New York, N. Y.—G.
C. E. Husted, Edward Ford Plate Glass, Rossford, Ohio.—G.

Charles Ingram, Clinchfield Products Corp., 350 Madison Ave., New York, N. Y.—W. W.
[1] ————, Iron City Sanitary Mfg. Co., Pittsburgh, Pa.—E.

[1] Company has named no representative.

D. C. Irwin, Potters Supply Co., East Liverpool, Ohio.—W. W.
M. Ise, Nippon Toki Kwaisha Noritake, Nagoya City, Japan.—W. W.

C. E. Jackson, Warwick China Co., Wheeling, W. Va.—W. W.
H. S. Jacoby, H. K. Ferguson Co., 6523 Euclid Ave., Cleveland, Ohio.
J. F. Jeffery, The Champion Porcelain Co., Detroit, Mich.—W. W.

G. C. Kalbfleisch, Standard Sanitary Mfg. Co., Tiffin, Ohio.—W. W.
B. C. Keeler, Mason City Brick & Tile Co., Mason City, Iowa.—H. C. P.
R. B. Keplinger, Metropolitan Paving Brick Co., Canton, Ohio.—H. C. P.
O. W. Ketcham, O. W. Ketcham Co., 125 N. 18th St., Philadelphia, Pa.—T. C.
P. S. Kier, Kier Fire Brick Co., Pittsburgh, Pa.
C. J. Kirk, Universal Sanitary Mfg. Co., New Castle, Pa.—W. W.
H. F. Kleinfeldt, Abbe Engineering Co., 50 Church St., New York, N. Y.
Frank P. Knight, Mineral Products Co., 50 Congress St., Boston, Mass.—W. W.
W. F. Knoesel, Mitchell Clay Mfg. Co., 5627 Manchester Ave., St. Louis, Mo.—R.
Walter J. Kohler, Kohler Company, Kohler, Wis.—E.
John B. Krauss, Portsmouth Stove & Range Co., Portsmouth, Ohio.—E.
John Kruesi, American Lava Corp., Chattanooga, Tenn.—W. W.
John C. Kurtz, Bausch & Lomb Optical Co., Rochester, N. Y.—G.

H. S. Langworthy, Jewettville Clay Products Co., Jewettville, N. Y.—H. C. P.
G. W. Lapp, Lapp Insulator Co., Inc., Leroy, N. Y.—W. W.
S. B. Larkins, The National China Co., Salineville, Ohio.—W. W.
W. H. Lentz, U. S. Gauge Co., Sellersville, Pa.
Chas. H. Leonard, Grand Rapids Refrigerator Co., Grand Rapids, Mich.—E.
H. D. Lillibridge, American Encaustic Tiling Co., Zanesville, Ohio.—W. W.
W. C. Lindemann, A. J. Lindemann & Hoverson Co., Milwaukee, Wis.—E.
H. B. Little, Baltimore Enamel & Novelty, Baltimore, Md.—E.
D. W. Loomis, H. L. Dixon Co., Box 140, Pittsburgh, Pa.—G.
W. B. Louthan, Louthan Mfg. Co., East Liverpool, Ohio.—W. W.

Atholl McBean, Gladding, McBean & Co., San Francisco, Calif.—T. C.
F. R. McCannell, Milton Pressed Brick Co., Milton, Ont., Canada.—H. C. P.
[1] ————, McLain Fire Brick Co., Wellsville, Ohio.—R.
T. A. McDonald, Coonley Mfg. Co., Cicero, Ill.—E.
Taine G. McDougal, A-C Spark Plug Co., Flint, Mich.—W. W.
[1] ————, McLanahan-Watkins Co., Charlotte Court House, Va.—R.
D. E. McNicol, D. E. McNicol Pottery Co., East Liverpool, Ohio.—W. W.
P. S. MacMichael, Northern Clay Co., Auburn, Wash.—T. C.
C. S. Maddock, Jr., Thomas Maddock's Sons Co., Trenton, N. J.—W. W.
Frank B. Mahoney, Humphryes Mfg. Co., Mansfield, Ohio.—E.
A. T. Malm, Norton Co., Worcester, Mass.—R.
Werner Malsch, Roessler & Hasslacher Chemical Co., New York City.—W. W.
R. A. Manegold, Dings Magnetic Separator Co., Milwaukee, Wis.—E.
Thos. S. Mann, Pacific Stoneware Co., Portland, Ore.—W. W.
J. M. Manor, Golding Sons Co., East Liverpool, Ohio.—W. W.
H. B. Manton, Robinson Clay Products Co., 1100 Second Natl. Bldg., Akron, Ohio.—H. C. P.

[1] Company has named no representative.

Jas. P. Martin, Lancaster Iron Works, Inc., Lancaster, Pa.—H. C. P.
John D. Martin, Straitsville Impervious Brick Co., New Straitsville, Ohio.—H. C. P
L. H. Maxfield, Illinois Glass Co., Alton, Ill.—G.
W. H. Mead, Whiting-Mead Commercial Co., Los Angeles, Calif.—E.
M. B. Meanley, Jones Hollow Ware Co., Baltimore, Md.—E.
L. D. Mercer, United Alloy Steel Corp., Canton, Ohio.—E.
D. M. Miller, Crossley Machine Co., Trenton, N. J.
G. C. Mitchell, Pope-Gosser China Co., Coshocton, Ohio.—W. W.
S. Momoki, Toyo Toko Kwaisha Shinozaki, Kokura City, Japan.—W. W.
E. T. Montgomery, Montgomery Porcelain Products Co., Franklin, Ohio.—W. W.
[1] ————, Moore & Munger, New York City.—W. W.
S. I. Morley, Crescent China Co., Alliance, Ohio.—W. W.
L. A. Morris, Florida China Clay Co., Box 83, Leesburg, Florida.—W. W.
H. C. Mueller, Mueller Mosaic Co., Trenton, N. J.—W. W.
L. A. Munro, Brunner Mond & Co., Ltd., Northwich, England.—W. W.

J. H. M. Nash, Hazel-Atlas Glass Co., Wheeling, W. Va.—G.
[1] ————, National Lime Association, Washington, D. C.
R. N. Newcomb, Charles Engelhard, Inc., 30 Church St., New York, N. Y.—W. W.
F. P. Nickerson, The W. S. Tyler Co., Cleveland, Ohio.
[1] ————, N. C. Geological & Economic Survey, Raleigh, N. C.

P. C. Olsen, South Amboy Terra Cotta Co., New York City.—T. C.
F. B. Ortman, Tropico Potteries, Inc., Glendale, Calif.—T. C.
Edward Orton, Jr., Standard Pyrometric Cone Co., Columbus, Ohio.

Thos. W. Pangborn, Pangborn Corporation, Hagerstown, Md.—E.
G. W. Parker, Parker-Russell Mining & Mfg. Co., St. Louis, Mo.—R.
Henry T. Parst, Electric Porcelain & Mfg. Co., Trenton, N. J.—W. W.
[1] ————, Pennsylvania Salt Mfg. Co., Pittsburgh, Pa.
R. O. Perrott, Hadfield-Penfield Steel Co., Bucyrus, Ohio.—R.
[1] ————, The Pfaudler Co., Rochester, N. Y.—E.
G. Q. Phillips, Olean Tile Co., Olean, N. Y.—W.
W. H. Phillips, Smith-Phillips China Co., East Liverpool, Ohio.—W. W.
E. Bertram Pike, Cortland Grinding Wheels Corp., Chester, Mass.—R.
F. G. Porter, Globe Brick Co., Box 765, E. Liverpool, Ohio.—H. C. P.
A. C. Postley, River Feldspar & Milling Co., Middletown, Conn.—W. W.
H. W. Powell, Crane Enamelware Co., Chattanooga, Tenn.—E.
W. H. Powell, Atlantic Terra Cotta Co., 350 Madison Ave., New York City.—T. C.
F. C. Preston, Dover Fire Brick Co., Cleveland, Ohio.—R.
W. S. Primley, Midland Terra Cotta Co., Chicago, Ill.—T. C.
B. S. Purinton, East Liverpool Potteries Co., Wellsville, Ohio.—W. W.

C. H. Rasmussen, Perth Amboy Tile Co., Perth Amboy, N. J.—W. W.
[1] ————, Reading Fire Brick Works, Reading, Pa.—R.
F. H. Reagan, Locke Insulator Co., Baltimore, Md.—W. W.
Ernest Richardson, Ingram-Richardson Mfg. Co., Beaver Falls, Pa.—E.
E. A. Richardson, The Libbey Glass Mfg. Co., Toledo, Ohio.—G.
W. Riehl, Hanovia Chemical & Mfg. Co., Chestnut St. & N. J. R. R. Ave., Newark, N. J.

[1] Company has named no representative.

Dewitt F. Riess, The Vollrath Co., Sheboygan, Wis.—E.
John T. Roberts, Stockton Fire Brick Co., 915 Rialto Bldg., San Francisco, Calif.—R.
F. E. Robinson, Garfield Fire Clay Co., Robinson, Ind. Co., Pa.—R.
Wm. H. Robinson, The Colonial Co., E. Liverpool, Ohio.—W. W.
J. Rodgers, The Product Sales Co., Baltimore, Md.
Otto Rosenstein, Illinois-Pacific Glass Co., 15th & Folsom Sts., San Francisco, Calif.—G.

B. E. Salisbury, Pass & Seymour, Inc., Solvay, N. Y.—W. W.
B. E. Salisbury, The Onondaga Pottery Co., Syracuse, N. Y.—W. W.
T. H. Sant, The John Sant & Sons Co., East Liverpool, Ohio.—W. W.
[1]————, Scranton Enameling Co., Scranton, Pa.—E.
J. M. Seasholtz, J. M. Seasholtz Co., Reading, Pa.—E.
Kenneth Seaver, Harbison-Walker Refractories Co., Pittsburgh, Pa.—R.
C. L. Sebring, The Sebring Pottery Co., Sebring, Ohio.—W. W.
F. H. Sebring, Salem China Co., Salem, Ohio.—W. W.
J. F. Sheehy, Alhambra Tile Co., Newport, Ky.—E.
Jos. M. Sherburne, Lindsay Light Co., 161 E. Grand Ave., Chicago, Ill.—E.
Alvin G. Sherman, Detroit Vapor Stove Co., Detroit, Mich.—E.
Geo. Shoemaker, The Clay Products Co., Brazil, Ind.—H. C. P.
Herbert Sinclair, Star Porcelain Co., Trenton, N. J.—W. W.
Geo. H. Slater, Carr-Lowrey Glass Co., Baltimore, Md.—G.
J. F. Sinclair, Jeffery-Dewitt Ins. Co., Kenova, W. Va.—W. W.
F. Goodwin Smith, Hartford-Empire Co., Hartford, Conn.—G.
H. P. Smith, Joseph Dixon Crucible Co., Jersey City, N. J.—R.
N. G. Smith, Maine Feldspar Co., Auburn, Maine.—W. W.
W. H. Smith, Canadain General Electric Co., Ltd., Peterborough, Canada.—W. W.
W. L. Smith, Jr., Taylor, Smith & Taylor Co., Chester, W. Va.—W. W.
H. F. Spier, N. J. Pulverizing Co., New York City.—W. W.
H. F. Staley, Metal & Thermit Corp., New York City.—E.
W. S. Stapler, Stevens, Inc., 101 Marietta St., Atlanta, Ga.—R.
[1]————, Stettiner Chamottefabrik, Akt.-Ges. vorm Didier, Stettin, Schwarzer, Damm lu 13 a, Germany.
Douglas F. Stevens, Acme Brick Co., 412 Adams Bldg., Danville, Ill.—H. C. P.
A. H. Stewart, Phoenix Glass Co., Pittsburgh, Pa.—G.
T. A. Stoelzle, Karr Range Co., Belleville, Ill.—E.
E. C. Sullivan, Corning Glass Works, Corning, N. Y.—G.
R. A. Swam, Denny-Renton Clay & Coal Co., Seattle, Wash.—T. C.

David S. Taylor, H. D. Pochin & Co., Ltd., Worsley St., Manchester, England.—W. W.
Homer J. Taylor, Knowles, Taylor & Knowles Co., E. Liverpool, Ohio.—W. W.
G. R. Thomas, R. Thomas & Sons Co., East Liverpool Ohio.—W. W.
J. B. Thomas, Electro-Alloys Co., Taylor St., Elyria, Ohio.—E.
Andrew Thompson, Titanium Alloy Mfg. Co., Niagara Falls, N. Y.—E.
M. W. Thompson, Hall China Co., E. Liverpool, Ohio.—W. W.
Frank W. Thropp, Eureka Flint & Spar Co., Trenton, N. J.—W. W.
C. H. Tiebout, Jr., Gleason-Tiebout Glass Co., Brooklyn, N. Y.—G.
F. J. Tone, Carborundum Co., Niagara Falls, N. Y.—R.
Karl Turk, Porcelain Enamel & Mfg. Co., Baltimore, Md.—E.
Lance Turnbull, Johnson Porter Clay Co., McKenzie, Tenn.—W. W.
Jas. Turner, Cook China Co., Trenton, N. J.—W. W.

[1] Company has named no representative.

R. T. Vanderbilt, R. T. Vanderbilt Co., 50 E. 42nd St., New York, N. Y.—W. W.
[1] ————, Vitrefrax Co., Los Angeles, Calif.—R.
Josef Vollkommer, Vitro Mfg. Co., Pittsburgh, Pa.—E.
W. J. Vollrath, Polar Ware Co., Sheboygan, Wis.—E.

F. W. Walker, Associated Tile Mfrs., Beaver Falls, Pa.—W. W.
F. W. Walker, Jr., Beaver Falls Art Tile Co., Beaver Falls, Pa.—W. W.
Harry Watkin, Edwin M. Knowles China Co., Newell, W. Va.—W. W.
August Weber, Jr., Weber Electric Co., Schenectady, N. Y.—W. W.
W. W. Wehrle, The Wehrle Co., Newark, Ohio.—E.
Edgar H. Weil, Vitreous Enameling Co., Cleveland, Ohio.—E.
W. E. Wells, Homer-Laughlin China Co., E. Liverpool, Ohio.—W. W.
Frank H. Whelden, Detroit Star Grinding Wheel Co., 111 Cavalry Ave., Detroit, Mich. —R.
W. B. Whitney, Springfield Paving Brick Co., Box 403, Springfield, Ill.—H. C. P.
C. W. Williams, Electrical Refractories Co., E. Clark St., E. Palestine, Ohio.—R.
J. A. Williams, Mitchell-Bissell Co., New York City.—W. W.
[1] ————, Wolverine Porcelain Co., Detroit, Mich.—E.
Wm. J. Woods, Pennsylvania Pulverizing Co., Lewistown, Pa.—W. W.
A. P. Woolfolk, Standard Sanitary Mfg. Co., Pittsburgh, Pa.—E.

R. T. Young, The Roseville Pottery Co., Zanesville, Ohio.—A.

A. S. Zopfi, Buckeye Clay Pot Co., Toledo, Ohio.—G.
E. G. Zorn, Industrial Publications, Inc., 407 S. Dearborn St., Chicago, Ill.—H. C. P.

PERSONAL NOTES

Howard C. Arnold has become affiliated lately with the Tiffany Enameled Brick Company of Momence, Illinois, Box 323.

Alice A. Ayars has returned to the New Amsterdam Hotel, Cleveland, Ohio, from Coconut Grove, Fla., where she has been visiting her parents and her brother, E. E. Ayars.

Harold D. Barger, formerly salesman for the Wellsville Fire Brick Co., Wellsville, Mo., is living at 1927 E. 71st St., Cleveland, Ohio.

Richard S. Bradley has moved from Mexico, Mo., to Bement, Illinois.

Emil Bronland, lately of Seattle, Wash., is now in Schumacher, Ont., Canada.

O. I. Chorman, of the Pfaudler Co., has been transferred from Rochester to Niagara Falls, N. Y.

W. W. Coates, Jr., announces his removal from Carrs Station, Ga., where he was affiliated with the Dixie Fireproofing Co., Macon, Ga., to 2810 Tracy Ave., Kansas City. He is now associated with the Coats Mfg. Co.

Julian Corman, of Murphysboro, Ill., is at present at 6016 Bartmer St., St. Louis, Mo.

George B. Cunning is now living at 309 W. Fourth St., East Liverpool, Ohio, having recently moved from New Lexington.

R. L. Frink who has been Director of Research, Glass Research Association, London, England, has accepted a position with the South Manchurian Railway Co., and is located at Darien, Manchuria.

C. C. Hayward, of the General Refractories Company, has been transferred from St. Louis, Mo., to Detroit, Mich.

[1] Company has named no representative.

I. A. Krusen, who was located at the Bureau of Mines, Columbus, Ohio, has accepted a position as General Manager of the Crescent Brick Co., Empire Bldg., Pittsburgh, Pa.

Frank E. Layman, formerly of Toronto, Can., has removed to 95 Harrison Street, East Orange, N. J.

Kai-Ching Lu, student member of the SOCIETY, has moved from Urbana, Ill., to 181 W. 10th Ave., Columbus, Ohio.

Frobisher T. Lyttle, of Scarsdale, N. Y., recently located at Whiting, Ind.

Hyman S. Magid has moved from Tiffin, Ohio, to Kokomo, Ind.

G. Z. Minton, of the Pittsburgh Plate Glass Co., has removed from Elwood, Ind., to the Crystal City, Mo. plant of the same Company.

G. V. Nightingale, recently of the Celite Products Co., Philadelphia, has resigned his position with this Company and is now associated as Sales Engineer with the Republic Flow Meters Co., of Chicago, in their Philadelphia office.

Clifford H. Parmelee, of the Onondaga Pottery Co., has moved from Warners, N. Y., to Syracuse.

E. E. Pressler is now affiliated with the U. S. Bureau of Standards, Washington, D. C.

Wm. A. Rhodes, formerly of the Albert Pick & Co., Chicago, Ill., is now associated with the Jackson Vitrified China Company, Jefferson County, Falls Creek, Pa.

Royal W. Taylor has removed from Canton, Ohio, to 611 S. Lawn Ave., Coshocton, Ohio.

C. Forrest Tefft, who has been connected with Fiske & Co., Inc., for the past ten years as ceramic engineer, plant manager and finally factory manager in charge of all plants, has left the services of this Company to enter into Ceramic Consulting Engineering with headquarters at Watsontown, Pa.

Edward J. Vachuska, former student at Alfred Univ., is now connected with Rutgers College, New Brunswick, N. J.

N. S. C. Walsh has moved from New York City to 4070 N. Main St., St. Louis, Mo.

The Weir Stove Company, of Taunton, Mass., has announced a change in the firm name and is now known as **The Glenwood Range Company.**

C. B. Young has moved from Columbus, Ohio, to New Lexington, Ohio.

THE ENAMEL DIVISION COÖPERATIVE RESEARCH

Manufacturers of enameled cast iron wares are coming to realize more and more that a large proportion of their imperfect wares is due to defective or unsuitable iron. This is true, not only with regard to chipping and crazing caused by unsuspected changes in the contraction of the iron, but more particularly with regard to the formation of pimples and blisters in the enamel. There is little doubt that every enameler of cast iron in the country, whether he makes sanitary wares, stove parts, or specialties, suffers a loss of thousands of dollars each year from the development of these pestiferous and seemingly inexplicable blisters.

Some preliminary research has been done on this subject, but the problem is so large and so intricate that it can never be adequately studied or solved by the individual research men and technical men in the industry. It requires the use of an experimental foundry and the coöperation of these practical enamelers and foundrymen with a group of highly trained metallurgists, metallographers, chemists, and physicists. Therefore, the Committee on Research of the Enamel Division of the AMERICAN CERAMIC SOCIETY has been exceedingly fortunate in securing the active coöperation of several depart-

ments of the U. S. Bureau of Standards in a thorough investigation of the relations between the composition and structure of cast irons and their enameling properties.

The Bureau will make a large number of melts of cast iron in its experimental cupola; will make test bars of each heat; will determine the physical properties of these test bars; will make enameling tests of castings from each heat; will make chemical analyses of each heat; and conduct metallographic studies of the iron of each heat before and after enameling. The tentative program as outlined will mean that active work will be conducted by the Bureau on this problem for at least one year and the cost to the Bureau will be somewhere between five and ten thousand dollars annually. The only requirement it makes of the Enamel Division of the AMERICAN CERAMIC SOCIETY is that the Division furnish the pig iron and coke used in making the various melts, and cooperate in making the enameling tests. Later the Bureau will ask for practical shop tests of its findings.

While the amount of money to be spent by the Enamel Division is very small in comparison with that to be expended by the Bureau, it will amount to a considerable sum, possibly a thousand dollars. To raise this fund, the Division has established a Cast Iron Research Fund, and is asking every firm enameling cast iron in this country, and others indirectly interested in the development of the industry, to contribute $50.00 each to the fund. The Division pledges its word that every cent contributed will be spent for research in the enameling of cast iron. Each contributor will be listed in the records of the Division as a "Research Patron" of the Enamel Division for the year 1925.

Due to the generous contributions of material by one stove manufacturer and one sanitary ware manufacturer, and to pledging of funds by individual members of the Committee, this investigation is now under way at the Bureau of Standards. If you are interested in reducing your enameling losses, and at the same time in taking your part in a movement for the welfare of the whole industry, please send us a check.

COMMITTEE ON RESEARCH,

Homer F. Staley, Metal & Thermit Corp., *Chairman*
E. P. Poste, Pfaudler Co., Elyria, Ohio, *Treasurer*
W. C. Lindemann, A. J. Lindemann & Hoverson Co.
M. E. Manson, Rundle Manufacturing Co.
L. G. Wassman, Wolff Manufacturing Co.

Kindly mark check "Cast Iron Research Fund," make it payable to E. P. Poste, and send it to Mr. Poste, care of The Pfaudler Co., Elyria, Ohio.

BALTIMORE-WASHINGTON SECTION MEETING, JANUARY 3, 1925[1]

The second meeting of the season of the Baltimore-Washington Section was held at the Lee House, Washington, D. C., on Saturday, January 3, at 7:00 P.M. As usual an informal dinner preceded the business of the meeting.

A paper was delivered by A. N. Finn, of the Glass Division of the Bureau of Standards on "Work of the Glass Division of the Bureau of Standards."

There was adopted a set time for meetings to be held in the future. These meetings to be held the first Saturday in each of the following months, February, April, October and December. The meetings are to alternate between the two cities.

[1] R. FUSSELBAUGH, Secretary-Treasurer, Baltimore-Washington Section.

PACIFIC NORTHWEST CLAY WORKERS' ASSN. AND PACIFIC NORTHWEST BRICK MFGRS.' ASSN.

The members of the Pacific Northwest Clay Workers' Assn. and Pacific Northwest Brick Manufacturers' Assn., held an interesting meeting Saturday, January 17, 1925, at Seattle. A banquet was served in the evening at the Olympic Hotel. The program consisted of papers presented by the following members.

"Clays and Shales of Puget Sound Region," by T. O. Smith, Univ. of Wash. "Discussion of Scumming of Brickwork," by M. E. Reynolds, Univ. of Wash. "Marketing Clay Products," W. A. Russell, Professor in College of Business Administration, Univ. of Wash. "The Insulation of Ceramic Kilns," by E. J. Bartells, Clay Products Delivery Co., Seattle. "Spalling Tests of Local Fire Brick," by Hewitt Wilson, Univ. of Wash.

CALIFORNIA SECTION MEETING

The California local section of the AMERICAN CERAMIC SOCIETY held a meeting in December at which time the following officers were elected: *President*, T. S. Curtis, of the Vitrefrax Co.; *Vice-President*, Robert Linton, Pacific Clay Products Company; *Treasurer*, H. A. Huisken, Vitrefrax Company; *Secretary*, Harry Davis, Tropico Potteries.

NEW JERSEY CLAY WORKERS IN ANNUAL MEETING

The Annual Meeting of the New Jersey Clay Workers Assn. and Eastern Section of the AMERICAN CERAMIC SOCIETY was held in the Assembly Room, Ceramics Building, Rutgers College, New Brunswick, N. J., on Dec. 19, 1924. The programs for the morning and afternoon sessions were as follows.

MORNING SESSION

Business Session.

Presidential Address—Charles W. Crane, Crossman Co., South Amboy, N. J.

"Factory Tests for Feldspar"—John M. Kreger, Woodbridge Ceramic Corporation, Woodbridge, N. J.

"Requisite Qualities of Glazed Wall Tile for Exterior Purposes"—G. H. Brown, Department of Ceramics, Rutgers College, New Brunswick, N. J.

Installation of new officers.

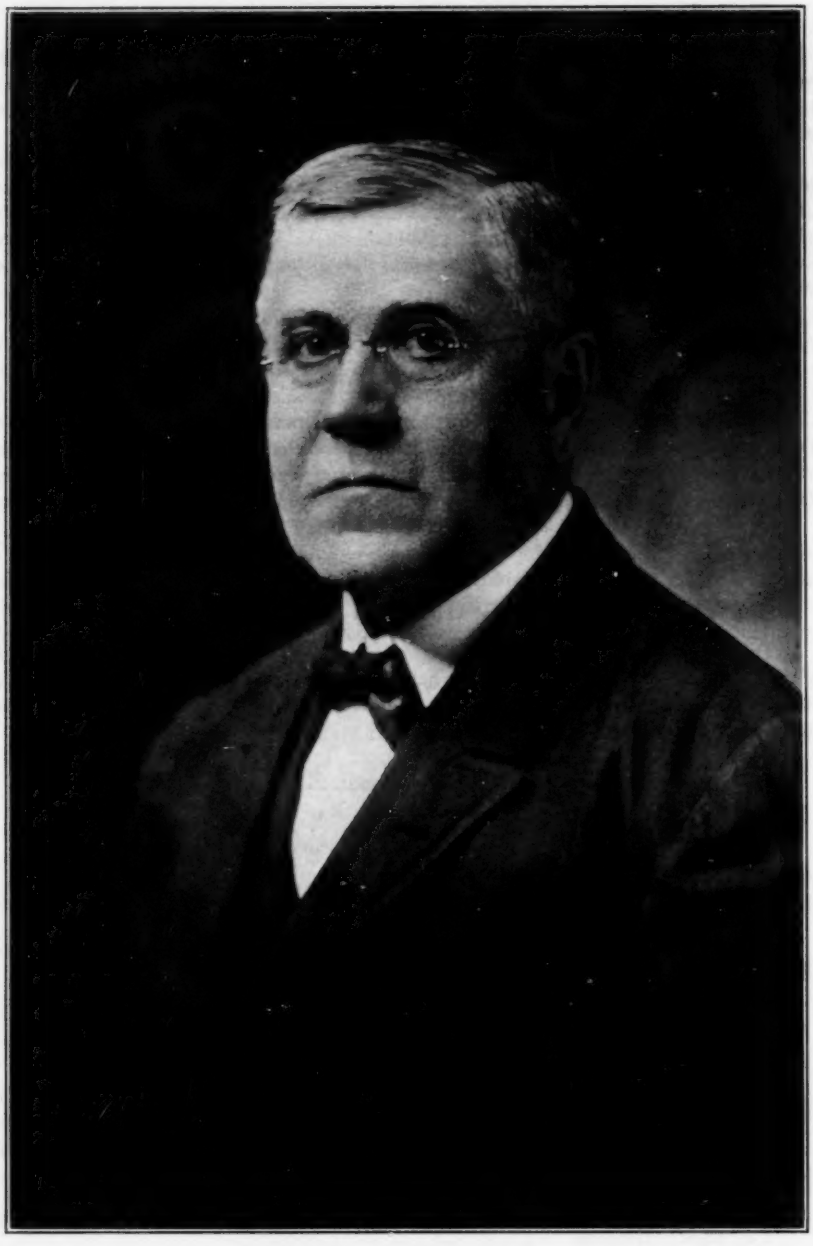
AFTERNOON SESSION

"Some Recent Developments in the Utilization of Casting Scrap in Casting Slips"—E. A. Slagle and Andrew Foltz, Lambertville, N. J.

"Zircon As a Constituent of Ceramic Bodies"—W. L. Shearer, Department of Ceramics, Rutgers College, New Brunswick, N. J.

"A Rapid Fire Tunnel Kiln for Smaller Wares"—Taine G. McDougal, A.-C. Spark Plug Co., Flint, Michigan.

"Oil-Firing as Applied to Ceramics"—L. A. Mekler, Combustion Engineer, Chicago Illinois.



William P. Blair.

NOTES AND NEWS

OBITUARY

Wm. P. Blair, Vice-President of the National Paving Brick Manufacturers' Association

William P. Blair, Active Vice-President of the National Paving Brick Manufacturers' Association, died at his home, 1859 Page Avenue, East Cleveland, Ohio, Tuesday morning, December 23, 1924, at 8:30 o'clock. Mr. Blair was founder and organizer of the National Paving Brick Manufacturers' Association, now nearly a quarter of a century old and his loss will be deeply felt not only by his family and close friends but by hundreds of men in the heavy clay products industry.

Mr. Blair was born at Plainfield, Ind., in 1848. He was educated at Earlham College, Richmond, Ind. In his early manhood he practiced law and was a member of the bar in Indiana. He also taught school and was interested in the lumber business.

He is survived by a widow, Viola, a son, Marion, of East St. Louis, Ill., and a daughter, Miss Jessie Blair, residing at home. He has been a resident of Cleveland for fifteen years.

Mr. Blair's interests and activities were concerned with the manufacture of paving brick. He became interested in the Good Roads Movement and was a pioneer in scientific research particularly that branch dealing with the character of sub-soils and their bearing power. Mr. Blair was one of the first of the Nation's Highway Engineers to realize that adequate drainage should be one of the prime considerations in the design and construction of the pavement structure.

As a member of the following organizations, Mr. Blair was exceedingly active:

Cleveland Chamber of Commerce, and a Councillor from the Cleveland Chamber to U. S. Chamber of Commerce
Cleveland Engineering Society
Civic League of Cleveland
Cleveland City Club
Cleveland Automobile Club
Cleveland Chapter, American Association of Engineers (Past President)
Trustee of the Ohio Federation of Good Roads
Member of the International Road Congress
Director of the American Road Builders' Association
Member American Society for Testing Materials
Member American Society for Municipal Improvements
Member of the following State Engineering Societies: Ohio, Illinois, Indiana, Wisconsin, Michigan, Iowa.

Mr. Blair was always active in helping to secure Federal Aid Legislation through the American Congress and left a sick bed to make a trip to Washington, D. C., to attend a meeting of the Highway Research Council. Upon his return to Cleveland he immediately left for Columbus, Ohio, to attend a meeting of the Ohio Good Roads Federation. He persistently refused to lighten his efforts at the oft repeated request of relatives, friends and business associates. Mr. Blair just as repeatedly insisted that the promotion of the proper design and construction of all pavements and particularly vitrified brick pavement was his absorbing interest in life.

His acquaintanceship was unusually wide in the United States, and spread to England and the Continent of Europe where he numbered many friends among those interested in highway development.

RESEARCH GRADUATE ASSISTANTSHIPS

Engineering Experiment Station, University of Illinois

To assist in the conduct of engineering research and to extend and strengthen the field of its graduate work in engineering, the University of Illinois maintains fourteen Research Graduate Assistantships in the Engineering Experiment Station. Two other such assistantships have been established under the patronage of the Illinois Gas Association. These assistantships, for each of which there is an annual stipend of $600 and freedom from all fees except the matriculation and diploma fees, are open to graduates of approved American and foreign universities and technical schools who are prepared to undertake graduate study in engineering, physics, or applied chemistry.

An appointment to the position of Research Graduate Assistant is made and must be accepted for two consecutive collegiate years of ten months each, at the expiration of which period, if all requirements have been met, the degree of Master of Science will be conferred. Half of the time of a Research Graduate Assistant (approximately 900 clock hours for each ten-month period) is required in connection with the work of the department to which he is assigned, the remainder being available for graduate study.

Nominations to these positions, accompanied by assignments to special departments of the Engineering Experiment Station, are made from applications received by the Director of the Station each year not later than the first day of April. The nominations are made by the Executive Staff of the Station, subject to the approval of the President of the University. Nominations are based upon the character, scholastic attainments, and promise of success in the principal line of study or research to which the candidate proposes to devote himself. Preference is given those applicants who have had some practical engineering experience following the completion of their undergraduate work. Appointments are made in the spring, and they become effective the first day of the following September. Vacancies may be filled by similar nominations and appointments at other times.

The Engineering Experiment Station, an organization within the College of Engineering, was established in 1903 for the purpose of conducting investigations in the various branches of engineering, and for the study of problems of importance to engineers and to the manufacturing and industrial interests of the State of Illinois. Research work and graduate study may be undertaken in architecture, architectural engineering, ceramic engineering, chemistry, civil engineering, electrical engineering, mechanical engineering, mining engineering, municipal and sanitary engineering, physics, railway engineering, and theoretical and applied mechanics.

The work of the Engineering Experiment Station is closely related to that of the College of Engineering, and the Heads of Departments in the College constitute the Executive Staff of the Station. Investigations are carried on by members of the Station staff and also by members of the instructional staff of the College of Engineering.

Additional information may be obtained by addressing

THE DIRECTOR
Engineering Experiment Station,
University of Illinois, Urbana, Ill.

PUBLICATIONS RELATING TO CERAMICS—BUREAU OF STANDARDS[1]

Scientific Papers

Number	Title	Price
*S 212	Melting Points of Some Refractory Oxides	
S 358	Concerning the Annealing and Characteristics of Glass	$0.10
S 373	Characteristics of Striae in Optical Glass	.05
S 393	Measurements of Thermal Dilatation of Glass at High Temperatures	.10

Technologic Papers

Number	Title	Price
T 1	Effect of Preliminary Heat Treatment upon the Drying of Clays	.10
*T 7	The Testing of Clay Refractories, with Special Reference to their Load-Carrying Ability at Furnace Temperatures	
T 10	The Melting Point of Fire Brick	.05
*T 17	The Function of Time in the Vitrification of Clays	
T 21	The Dehydration of Clays	.05
*T 22	The Effect of Overfiring upon the Structure of Clays	
*T 23	The Technical Control of the Colloidal Matter of Clays	
*T 30	Viscosity of Porcelain Bodies	
*T 31	Some Leadless Boro-Silicate Glazes Maturing at about 1100°C	
T 40	The Veritas Firing Rings	.05
*T 46	A Study of the Atterberg Plasticity Method	
T 50	The Viscosity of Porcelain Bodies High in Feldspar	.05
*T 51	Use of Sodium Salts in the Purification of Clays and in the Casting Process	
T 79	Properties of Some European Plastic Fire Clays	.10
T 80	Constitution and Microstructure of Porcelain	.25
T 85	Manufacture and Properties of Sand-Lime Brick	.10
T 104	The Effect of Size of Grog in Fire Clay Bodies	.10
T 105	Comparative Tests of Porcelain Laboratory Ware	.05
T 107	Comparative Tests of Chemical Glassware	.10
T 111	The Compressive Strength of Large Brick Piers	.10
T 116	Silica Refractories—Factors Affecting Their Quality and Methods of Testing the Raw Materials and Finished Ware	.20
T 120	Tests of Hollow Building Tile	.05
T 124	Constitution and Microstructure of Silica Brick and Changes Involved through Repeated Burnings at High Temperatures	.10
T 142	Materials and Methods Used in the Manufacture of Enameled Cast-Iron Wares	.20
T 144	The Properties of American Bond Clays and Their Use in Graphite Crucibles and Glass Pots	.10
T 155	Cements for Spark Plug Electrodes	.05
T 159	Porosity and Volume Changes of Clay Fire Bricks at Furnace Temperatures	.05
T 165	Enamels for Sheet Iron and Steel	.15

[1] The publications not starred may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C., at the prices stated. Those marked with a star are out of print, but may be consulted at leading libraries.

Number	Title	Price
T 196	High-Fire Porcelain Glazes	.05
T 227	American and English Ball Clays	.10
T 234	Methods of Measuring the Plasticity of Clays	.10
T 246	Wet-Process Enamels for Cast Iron	.10
T 262	Comparison of American and Foreign Clays as Paper Fillers	.15

Circulars

Number	Title	Price
C 119	Specifications for Lime-Flint Glass Tumblers	.05
C 164	U. S. Government Master Specification for Flat Glass for Glazing Purposes	.05

Specifications Issued by Federal Specifications Board

Copies can be obtained free of charge from the Chairman, Federal Specifications Board, Bureau of Standards, Washington, D. C.

Specification 243. U. S. Government Master Specification for Vitrified Chinaware.

Publications Appearing in the Transactions and Journals of the American Ceramic Society[1]

PORCELAIN, WHITEWARE AND ALLIED PRODUCTS

"A Study of the Vitrification Range and Di-Electric Behavior of Some Porcelains," *Trans.*, **12** (1910).

"The Measurement of Color of Whiteware and Whiteware Materials," *Trans.*, **13** (1911).

"High Voltage Insulators and High Potential Testing," *Trans.*, **14** (1912).

"The Viscosity of Porcelain Bodies," *Trans.*, **15** (1913).

"The Clark Viscosimeter," *Trans.*, **15** (1913).

"The Veritas Firing Rings," *Trans.*, **16** (1914).

"Study of the Atterberg Plasticity Method," *Trans.*, **16** (1914).

"Some of the Properties of White Porcelain Cement," *Trans.*, **16** (1914).

"The Viscosity of Porcelain Bodies," *Trans.*, **17** (1915).

"The Bureau of Standards Contrast Method for Measuring Transparency," *Trans.*, **17** (1915).

"Electrical Conductivity of a Porcelain Mixture and a Shale upon Heating," *Trans.*, **17** (1915).

"Notes on the Manufacture of Porcelain Pyrometer Tubes," *Trans.*, **18** (1916).

"The Constitution and Microstructure of Porcelain," *Trans.*, **18** (1916).

"Notes on the Production of Special Refractories—Marquardt Porcelain and Magnesium Aluminate," *Trans.*, **19** (1917).

"Note on the Temperature, Porosity, Volume Changes of Some Porcelain Bodies," *Trans.*, **19** (1917).

"Some Types of Porcelain," *Jour.*, **1** [9] (1918).

"Note on Certain Characteristics of Porcelain," *Jour.*, **1** [10] (1918).

"Effect of Time and Temperature on the Microstructure of Porcelain," *Jour.*, **2** [3] (1919).

[1] Copies of the *Transactions* and *Journals* may be consulted at leading libraries or may be obtained from the Secretary of the SOCIETY at Lord Hall, O. S. U., Columbus, Ohio.

"Impact Tests and Porosity Determinations on Some American Hotel China and Semi-Porcelain Plates," *Jour.*, **2** [3] (1919).

"Some Physical Properties of American Commercial Porcelain Bodies," *Jour.*, **2** [4] (1919).

"Special Spark Plug Porcelains," *Jour.*, **2** [7] (1919).

"Relation between the Composition and the Thermal Expansivity of Porcelain," *Jour.*, **2** [10].

"Further Studies on Porcelain," *Jour.*, **2** [10] (1919).

"The Solubility of Boric Acid Frits," *Jour.*, **3** [2] (1920).

"The Rate of Vitrification of Porcelain Molded under Different Conditions," *Jour.*, **3** [10] (1920).

"Solubility and Fusibility of Some Feldspar Frits," *Jour.*, **4** [6] (1921).

"High-Fire Porcelain Glazes," *Jour.*, **4** [9] (1921).

"Note on the Hardness of Glazes," *Jour.*, **4** [11] (1921).

"Earthenware Bodies and Glazes," *Jour.*, **4** [12] (1921).

"Comparative Tests of American and Foreign Tableware," *Jour.*, **5** [6] (1922).

"Impact Tests on Tableware," *Jour.*, **6** [2] (1923).

"The Effect of Variation in Firing on the Physical Properties of Vitreous China Bodies," *Jour.*, **6** [8] (1923).

"The Bonding Effect of Ball Clays in Fired Bodies," *Jour.*, **7** [2] (1924).

"An Apparatus for Measuring the Abrasive Hardness of Glazes," *Jour.*, **7** [5] (1924).

Refractories and Heavy Clay Products

"The Relation between the Porosity and Crushing Strength of Clay Products," *Trans.*, **12** (1910).

"The Behavior of Fire Bricks under Load Conditions at a Temperature of 1300°C," *Trans.*, **12** (1910).

"The Behavior of Fire Bricks under Load Conditions," *Trans.*, **13** (1911).

"The Relation between the Crushing Strength and Porosity of Clay Products," *Trans.*, **14** (1912).

"Notes on Load Tests Made on Magnesite, Chrome, and Silica Brick," *Trans.*, **14** (1912).

"The Melting Points of Refractory Materials," *Trans.*, **15** (1913).

"The Development of Special Refractory Bodies," *Trans.*, **15** (1913).

"Report on Rattler Tests Made on Brick Obtained from Paved Streets," *Trans.*, **16** (1914).

"The Relative Thermal Conductivities of Silica and Clay Refractories," *Trans.*, **16** (1914).

"Effect of Saturated Sodium Sulphate Solution upon the Structure of Clay Burned to Different Temperatures," *Trans.*, **17** (1915).

"Notes on Casting," *Trans.*, **17** (1915).

"A Method of Testing the Corrosive Action of Slag on Fire Brick," *Trans.*, **18** (1916).

"Note on the Volume Changes of Silica Brick Mixtures," *Trans.*, **18** (1916).

"Volume Changes of Some Commercial Silica Bricks on Heating," *Trans.*, **19** (1917).

"The Effect of Size of Grog in Fire Clay Bodies," *Trans.*, **19** (1917).

"Special Pots for the Melting of Optical Glass," *Jour.*, **1** [1] (1918).

"Porosity and Volume Changes of Clay Fire Brick at Furnace Temperatures," *Jour.*, **1** [6] (1918).

"Silica Refractories," *Jour.*, **1** [7] (1918).

"The Equipment of a Casting Plant for the Manufacture of Glass Pots," *Jour.*, **2** [8] (1918).

"Note on the Casting of Porcelain Glass Pots," *Jour.*, **2** [8] (1919).

"Siliceous Sagger Mixtures," *Jour.*, **3,** [1] (1920).

"Notes on the Load Behavior of Aluminous Refractories," *Jour.*, **3** [2] (1920).

"Notes on Porcelain Glass Pot Mixtures," *Jour.*, **3** [7] (1920).

"The Transverse Strength of Fire-Clay Tiles at Furnace Temperatures," *Jour.*, **4,** [7] (1921).

"Possibilities of Terra Cotta Castings," *Jour.*, **4** [11] (1921).

"Study of Some Bond Clay Mixtures," *Jour.*, **4** [11] (1921).

"Effectiveness of Different Methods of Making Absorption Determinations as Applied to Hollow Building Tile," *Jour.*, **5** [11] (1922).

"Capping for Compression Specimens," *Jour.*, **6** [5] (1923).

"Effect of Grog Additions on Fire Resistance of Hollow Tile," *Jour.*, **6** [6] (1923).

"Further Studies on Cast Glass Pots," *Jour.*, **6** [8] (1923).

"Progress Report on Specifications for Refractories," *Jour.*, **6** [10] (1923).

"Strength, Absorption and Freezing Resistance of Hollow Building Tile," *Jour.* **7** [3] (1924).

"Notes on the Behavior of Refractories in Glass Melting Furnaces," *Jour.*, **7** [8] (1924).

"The Laboratory Testing of Aluminous Refractories," *Jour.*, **7** [9] (1924).

Vitreous Enamels

"Ground Coat Enamels for Cast Iron," *Jour.*, **1** [2] (1918).

"Preparation and Application of Enamels for Cast Iron," *Jour.*, **1** [8] (1918).

"Control of Luster of Enamels," *Jour.*, **1** [9] (1918).

"Enamels for Cast Iron," *Jour.*, **1** [10] (1918).

"The Cleaning of Sheet Steel and Iron for Enameling Purposes," *Jour.*, **2** [11] (1919).

"Classification of Enamels for Sheet Steel," *Jour.*, **3** [12] (1920).

"The Cause and Control of Fish Scaling of Enamels for Sheet Iron and Steel," *Jour.*, **4** [8] (1921).

"Some Relations of Composition to Solubility of Enamels in Acids," *Jour.*, **4** [9] (1921).

"The Production of Some White Enamels for Copper," *Jour.*, **4** [10] (1921).

"Wet Process Enamels for Cast Iron," *Jour.*, **5** [10] (1922).

"The Effect of Some Substitutes for Tin Oxide on the Opacity of White Enamels for Sheet Steel," *Jour.*, **6** [5] (1922).

"The Relations between Composition and Properties of Enamels for Sheet Steel," *Jour.*, **6** [10] (1922).

"Factors Affecting the Warpage of Sheet Iron and Steel in Enameling," *Jour.*, **7** [5] (1924).

"The Development of Some Jewelry Enamels," *Jour.*, **7** [12] (1924).

Glass

"Variation in Soda, Lime, and Magnesia Content of a Glass of the Type RO_3SiO_2," *Trans.*, **17** (1915).

"Observations on the Formation of Seeds in Optical Glass," *Jour.*, **1** [2] (1918).

"Strength Tests of Plain and Protective Sheet Glass," *Jour.*, **1** [11] (1918).

"Procedure in the Manufacture of Optical Glass," *Jour.*, **2,** [6] (1919).

"Production of Selenium Red Glass," *Jour.*, **2** [11] (1919).

"Comparison Tests for Striae in Optical Glass by the Brashear Converging Light, Direct View Method, the Bureau of Standards Tank Immersion Method, and the Short, Range Projection Method," *Jour.*, **2** [12] (1919).

"Disintegration of Soda-Lime Glasses in Water," *Jour.*, **5** [8] (1922).

"The Microscopic Identification of Stones in Glass," *Jour.*, **7** [1] (1924).

"Tests on the Resistive Qualities of Soda-Lime Glasses to Water," *Jour.*, **6** [4] (1923).

"A Study of the Origin and Cause of Stones in Glass," *Jour.*, **6** [6] (1923).

"The Mechanical Strength of Glazing Glass," *Jour.*, **6** [9] (1923).

Miscellaneous

Raw Materials—Their Properties, Uses and Methods of Testing

"Note on the Viscosity of Clay Slips as Determined by the Clark Apparatus," *Trans.*, **12** (1910).

"Notes on the Preheating Treatment of Clays," *Trans.*, **12** (1910).

"The Dehydration of Clays," *Trans.*, **14** (1912).

"The Effect of Overburning on the Structure of Clays," *Trans.*, **15** (1913).

"Function of Time in the Vitrification of Clays," *Trans.*, **15** (1913).

"The Electrical Conductivity of Clays and Clay Suspensions," *Trans.*, **15** (1913).

"Study of Some Calcareous and Magnesium Slags," *Trans.*, **15** (1913).

"The Temperature Porosity Relations of a Clay Prepared in the Plastic and in the Moist Condition," *Trans.*, **15** (1913).

"A Note on the Reduction of Fe_2O_3," *Trans.*, **16** (1914).

"The Compression, Tensile, and Transverse Strength of Some Clays in the Dried States," *Trans.*, **16** (1914).

"The Flow of Clays under Pressure," *Trans.*, **16** (1914).

"A Laboratory Oven Provided with Recording Attachments for the Study of Drying Clays," *Trans.*, **16** (1914).

"Viscosity of Some Shales at Furnace Temperatures," *Trans.*, **16** (1914).

"The Use of Deflocculating Agents in the Washing of Clays and the Effect of the Process upon the Color," *Trans.*, **17** (1915).

"Note on Thermal Electric Phenomena Observed in Some Silicates," *Trans.*, **17** (1915).

"A Study of Fire Clay, Shale, and Surface Clay Mixtures with Reference to Their Porosity Temperature Relations," *Trans.*, **17** (1915).

"The Relation between the Modulus of Elasticity and the Porosity of Burned Clay," *Trans.*, **17** (1915).

"Deformation of Plastic Bodies under Compression as a Measure of Plasticity," *Trans.*, **17** (1915).

"Microscopic Investigation of Some Compounds Noted in the Systems Soda–Zinc Oxide–Silica and Soda–Zinc Oxide–Titanic Oxide–Silica," *Trans.*, **17** (1915).

"On the Attainment of Reliable Temperature Measurements in the Ceramic Industries by Means of Thermocouples," *Trans.*, **18** (1916).

"Softening Points of Potash, Feldspar–Steatite Mixtures," *Trans.*, **18** (1916).

"Heat Balance of a Continuous Tunnel Kiln," *Trans.*, **19** (1917).

"An Instrument for Measuring Plasticity," *Trans.*, **19** (1917).

"Properties of Some American Bond Clays," *Trans.*, **19** (1917).

"Test of a Producer Gas-Fired Periodic Kiln," *Jour.*, **1** [1] (1918).

"Tests of Clays and Limes by the Bureau of Standards Plasticimeter," *Jour.*, **1** [3] (1918).

"Applications of the Polarizing Microscope in Ceramics," *Jour.*, **2** [9] (1919).

"The Use of American Raw Materials in the Manufacture of Whiteware Pottery," *Jour.*, **3** [2] (1920).

"The Testing of Clays for Concrete Aggregate," *Jour.*, **3** [3] (1920).

"Effect of Aluminum Chloride upon Clays," *Jour.*, **3** [12] (1920).

"Use of American Raw Materials in the Manufacture of Whiteware Pottery," *Jour.*, **3** [12] (1920).

"Note on the Effect of Time on the Drying Shrinkage of Clays," *Jour.*, **4** [4] (1921).

"The Water Smoking of Clays," *Jour.*, **4** [5] (1921).

"Absorption of Sodium Hydroxide by Kaolins," *Jour.*, **4** [6] (1921).

"Use of Special Oxides in Porcelain Bodies," *Jour.*, **4** [10] (1921).

"The Plasticity of Clays," *Jour.*, **5** [6] (1922).

"Comparative Tests of Foreign and Domestic Whiting," *Jour.*, **5** [12] (1922).

"Effect of Hydrogen Ion Concentration upon Clay Suspensions," *Jour.*, **6** [9] (1923).

"Thermal Expansion of Fused Quartz," *Jour.*, **7** [11] (1924).

REVISED LIST OF PUBLICATIONS ON CERAMIC INVESTIGATIONS—BUREAU OF MINES[1]

The following list gives the title and author of various publications of the Ceramic Experiment Station, Columbus, Ohio, of the Bureau of Mines, together with other ceramic publications of the Bureau, which have been published in technical journals and by coöperating agencies. The list also includes the publications on ceramics which have been issued as bulletins, technical papers, or mimeograph Report of Investigations of the Bureau.

Papers Published in the Technical Press

H. G. Schurecht, "The Effect of Some Electrolytes on the Properties of Clays," *Jour. Amer. Ceram. Soc.*, **1** [3], 201 (1918).

H. G. Schurecht, "A Pycnometer Operated as a Volumeter," *Jour. Amer. Ceram. Soc.*, **1** [8], 556 (1918).

H. G. Schurecht, "The Properties of Some Ohio and Pennsylvania Stoneware Clays," *Jour. Amer. Ceram. Soc.*, **1** [4], 267 (1918).

M. C. Booze, "The Fusibility of Graphite Ash and Its Influence on the Refractoriness of Bond Clay," *Jour. Amer. Ceram. Soc.*, **2** [1], 65 (1919).

R. T. Stull, "Behavior under Brass Foundry Practice of Crucibles Containing Ceylon, Canadian and Alabama Graphites," *Jour. Amer. Ceram. Soc.*, **2** [3] (1919).

H. G. Schurecht, "Experiments in Dead-Burning Dolomite," *Jour. Amer. Ceram. Soc.*, **2** [4], 291 (1919).

R. T. Stull and H. G. Schurecht, "Effect of Variable Pressure and Tar Content on the Briquetting of Alabama Graphite," *Jour. Amer. Ceram. Soc.*, **2** [5], 391 (1919).

M. C. Booze, "Some Properties of Bond Clays for Graphite Crucibles," *Jour. Amer. Ceram. Soc.*, **2** [6], 461 (1919).

H. G. Schurecht, "The Effect of Electrolytes on the Properties of Graphite Crucible Bodies," *Jour. Amer. Ceram. Soc.*, **2** [6], 443 (1919).

H. G. Schurecht, "A Machine for Testing the Hot Crushing Strength of Firebrick," *Jour. Amer. Ceram. Soc.*, **2** [8], 602 (1919).

R. T. Stull, "The Position of Clay Products in the Field of Earthen Products," *Brick & Clay Record*, March 6 (1919).

R. T. Stull, "Graphites and Bond Clays for Crucible Making Purposes," Proc. 22nd Convention, Am. Mining Congress, p. 766, November 17–21 (1919).

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[1] Compiled by L. E. Geyer, Bureau of Mines.

R. T. Stull, "The Need of Technical Assistance in the Brick Industry," *Jour. Amer. Ceram. Soc.*, **3** [3], 180 (1920).

R. T. Stull, "Government Service in Developing the Clay Industry," *The Clay Worker*, March 25 (1920).

H. G. Schurecht, "Elutriation Tests on American Kaolins," *Jour. Amer. Ceram. Soc.*, **3** [5], 355 (1920).

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CALENDAR OF CONVENTIONS

Organization	Date	Place
AMERICAN CERAMIC SOCIETY (Annual Meeting)	Feb. 16–21, 1925	Columbus, Ohio
Am. Assn. of Flint and Lime Glass Mfrs. (Annual Meeting)	July, 1925	Atlantic City, N. J.
Am. Electrochemical Soc.	April 23–25, 1925	Niagara Falls, N. Y.
Am. Soc. for Testing Materials	June 22–26	Atlantic City, N. J.
Am. Concrete Institute	Feb. 24–27, 1925	Chicago, Ill.
Brussells International and Commercial Fair	March 25–April 8	Brussells, Belgium
Common Brick Mfrs. Assn.	Feb. 9–13, 1925	Chicago, Ill.
Manufacturing Chemists' Assn.	June, 1925	New York City
Natl. Assn. of Mfrs.	May, 1925	New York City
Natl. Assn. of Mfrs. of Pressed and Blown Glassware	March, 1925	Pittsburgh, Pa.
Natl. Assn. of Stove Mfrs.	May 13–14, 1925	New York City
Natl. Chemical Equipment Assn.	June 22–27, 1925	Providence, R. I.
Natl. Clay Products Industries Assn.	April, 1925	Chicago, Ill.
Natl. Lime Association	May, 1925	
Natl. Exposition of Chem. Industries	Sept. 28–Oct. 3, 1925	New York City
Tile & Mantel Contractors' Assn. of America	Feb. 9, 1925	Louisville, Ky.

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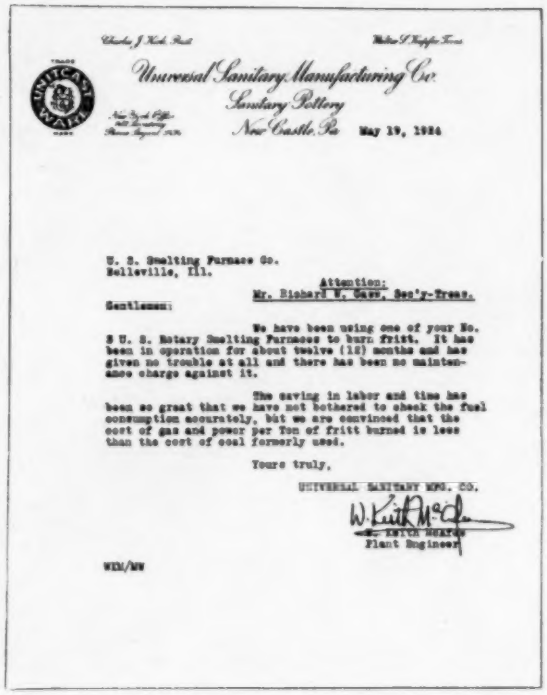

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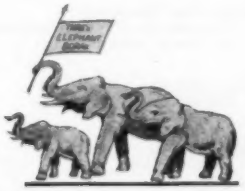

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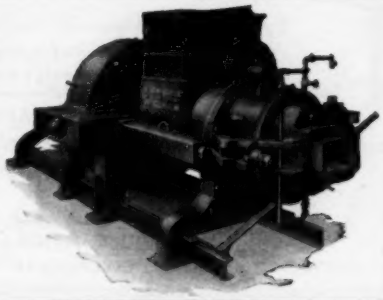

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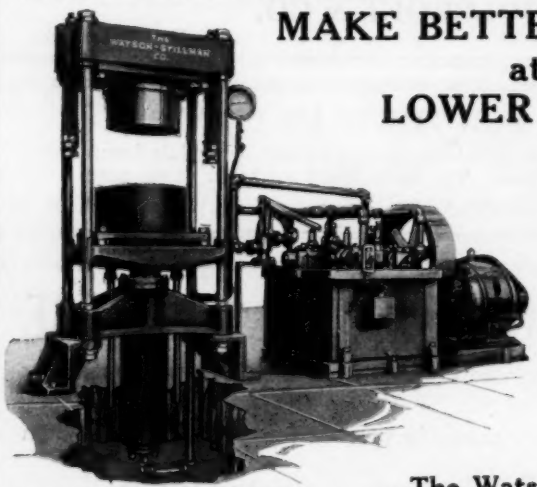

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CERAMIC BREVITIES

The Republic Flow Meters Co., 2240 Diversey Parkway, Chicago, Ill., have issued Bulletin CM-27 on the "Measurement of Coal". This is an extremely interesting bulletin giving results of tests and a description of the Republic Coal Meter, photographs of the inside workings of the meter as well as installations. The point where the measurement of coal is taken is shown and a chart showing the volumetric measurement of coal "equal volume—equal weight" is interesting to users of coal.

The Brown Instrument Co., 4505 Wayne Ave., Philadelphia, Pa., have just issued a very interesting bulletin on "Measuring CO_2 Electrically". No ceramic engineer having the interests of his plant at heart should fail to write for this valuable bulletin No. 32.

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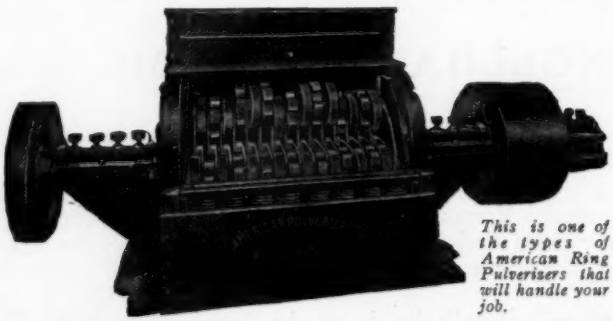

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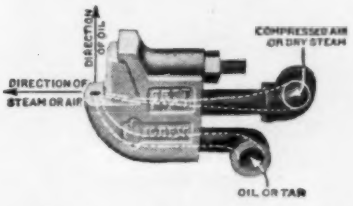

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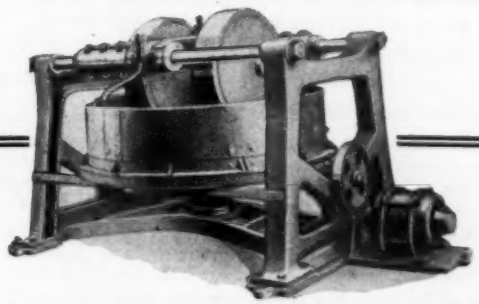

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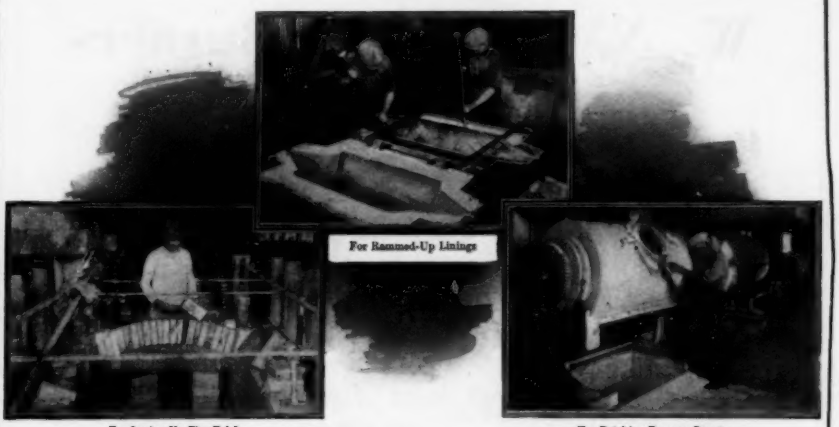

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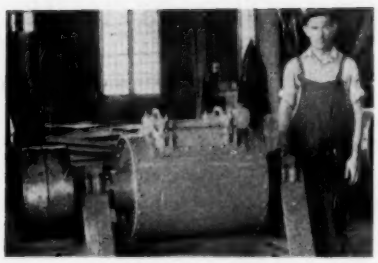

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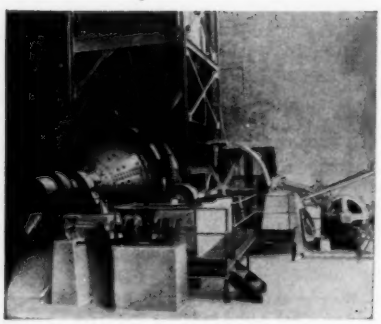

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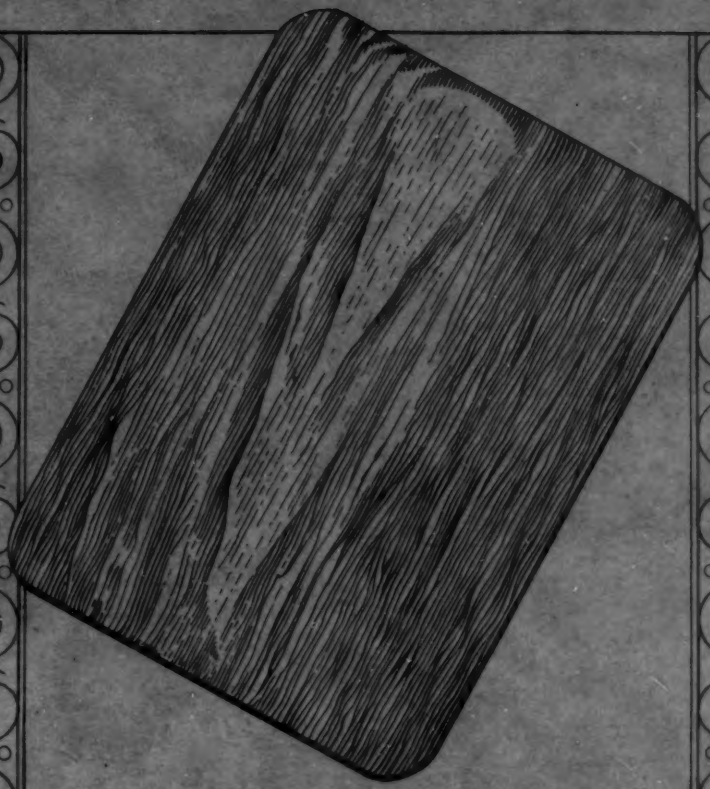

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